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ANVIK RIVER SALMON ESCAPEMENT STUDY, 1989

By

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INTRODUCTION

The Anvik River (Figure 1) is the largest producer of summer chum salmon (*Oncorhynchus keta*) in the Yukon River drainage. Buklis (1982a) estimated that the Anvik River alone accounts for 35% of the total production. Other known major spawning populations occur in the Andreafsky, Rodo, Nulato, Gisasa, Hogatza, Melozitna, Tozitna, Chena, and Salcha Rivers (Figure 1). Summer chum salmon spawn in lesser numbers in other tributaries of the Yukon River. Chinook (*O. tshawystcha*) and pink (*O. gorbuscha*) salmon occur in the Anvik River coincidentally with summer chum salmon. Coho salmon (*O. kisutch*) are known to occur in the fall.

Commercial and subsistence harvests of Anvik River summer chum salmon occur throughout the mainstem Yukon River from the coast of the delta to the mouth of this tributary stream. Set and drift gill nets are the legal fishing gear in Districts 1, 2, and 3, while set gill nets and fishwheels are used in District 4. Most of the effort and harvest on this stock occurs in Districts 1 and 2 and in the lower portion of District 4. Fish taken commercially in the lower three districts are fresh frozen, while District 4 is primarily a roe fishery due to poor flesh quality and distance from market. Commercial and subsistence summer chum salmon fisheries in the remainder of District 4 and in District 6 are supported by stocks other than the Anvik River stock. Very few summer chum salmon are harvested in District 5 due to the lack of significant spawning populations in that portion of the drainage.

A stock identification study on Yukon River summer chum salmon using protein electrophoresis techniques is being conducted by the United States Fish and Wildlife Service (USFWS). This study was initiated in 1987 and only preliminary results are available. A small-scale stock identification investigation using scale pattern analysis was recently conducted by the Alaska Department of Fish and Game (ADF&G). Results of this pilot study indicates that separation of chum salmon stocks by scale pattern analysis is probably not feasible (Wilcock 1988).

In the lower portion of the Yukon River (Districts 1, 2, and 3), run timing of chinook and summer chum salmon greatly overlap from river-ice breakup until June or early July. During this time period management of the lower Yukon River has traditionally been directed at chinook salmon. Large-mesh gill nets (stretch mesh greater than 6") were employed to target chinook salmon for harvest. Although large-mesh gill nets were very efficient in harvesting chinook salmon, the associated harvest of summer chum salmon was small in relation to the size of the run. Prior to the 1985 season, however, the Alaska Board of Fisheries, in an attempt to increase the harvest of summer chum salmon in the lower river, directed that special small-mesh (stretch mesh maximum of 6 in) fishing periods should be allowed during the chinook salmon season if the summer chum salmon run is of sufficient size to support the additional exploitation, and that the incidental harvest of chinook salmon during these small-mesh fishing periods did not adversely affect conservation of that species. During the 1986, 1988, and 1989 seasons, management strategies which restricted gill net mesh size to a maximum of 6 in were implemented during the directed chinook salmon season to take advantage of very strong summer chum salmon runs. This management strategy allowed more fishing time and increased the exploitation on the summer chum salmon run. The incidental harvest of chinook salmon during these special small-mesh periods did not adversely affect the status of the chinook salmon resource. The District 4 commercial fishery is directed primarily at chum salmon. Subsistence fisheries in all four districts take summer chum salmon primarily for sled dog food.

Summer chum salmon escapements to the major spawning areas in the Yukon River drainage have been estimated by aerial survey from fixed-wing aircraft on a consistent basis since the early 1970's. Aerial surveys are subject to error and variability due to weather, stream conditions, timing of the survey relative to spawning stage, and subjectivity and experience on the part of the observer. The counts obtained are only indices of abundance since not all salmon present on the day of the survey are usually seen, and earlier and later spawners are not present. However, these indices, if obtained under standardized conditions, can be used to monitor the relative abundance of spawning escapements. Aerial surveys are the most feasible method of assessing salmon escapements in terms of cost and staff limitations in a watershed as immense and remote as that of the Yukon River. Escapement objectives have been established for both chinook and chum salmon in selected tributary streams for which there is a sufficient historical data base (ADF&G 1988).

Intensive studies are conducted for a few important and representative tributary stream salmon spawning populations in addition to the aerial survey program. The Anvik and Andreafsky Rivers were chosen for summer chum salmon research studies in 1972 and 1981, respectively. Project results for the these escapement studies have been reported by Lebida (1973), Trasky (1974, 1976), Mauney (1977, 1979, 1980), Mauney and Geiger (1977), Mauney and Buklis (1980), Buklis (1981, 1982b, 1983, 1984a, 1984b, 1985, 1986, 1987), and Sandone (1989). Because of severe budget restrictions in 1989, the Andreafsky River project was discontinued. This report presents results of the Anvik River study for the 1989 field season.

The Anvik River (Figure 2) originates at an elevation of 1,300 feet and flows in a southerly direction approximately 120 miles to its mouth at mile 318 of the Yukon River. It is a narrow runoff stream with a substrate mainly of gravel and cobble. However, bedrock is exposed in some of the upper reaches. The Yellow River is a major tributary of the Anvik and is stained with tannic acid runoff. Downstream of the Yellow River confluence the Anvik River changes from a moderate gradient system to a low gradient system meandering through a much broader flood plain. Water clarity is reduced downstream of the Yellow River. Numerous oxbows, old channel cutoffs and sloughs are found throughout the lower river.

Salmon escapement was enumerated from two counting tower-sites above the Yellow River from 1972 to 1978. A site 5.5 miles above the Yellow River was used from 1972 to 1975, and a site at Robinhood Creek, 2.5 miles above the Yellow River, was used from 1976 to 1978. Aerial surveys were flown each year (except 1974) in fixed-wing aircraft to estimate salmon abundance below the tower site. High and turbid water often affects the accuracy of visual salmon enumeration from counting towers and aircraft.

The Electrodynamics Division of the Bendix Corporation developed a side-scanning sonar counter during the 1970's capable of detecting and counting salmon migrating along the banks of tributary streams. The sonar counter is designed to transmit a sonic beam along a 60 foot aluminum tube, or substrate. Echoes from salmon passing through the beam are reflected back to the transducer. The system electronics interpret the strength and number of the echoes, and tally salmon counts. Criteria for strength and frequency of the echoes are designed to optimize counting of salmon and minimize any non-salmon counts (i.e. debris or other fish species). Salmon escapement was enumerated by sonar beginning in 1979, replacing and proving superior to the tower-counting method. One sonar counter has been installed on each bank of the Anvik River near Theodore Creek each year. Aerial survey data indicates that virtually all summer chum salmon spawners are found upstream of this site.

METHODS AND MATERIALS

Sonar counters were operated without artificial aluminum substrate tubes throughout the season for the fifth consecutive year. Each sonar transducer was mounted on a rectangular aluminum frame. The east and west bank sites used in previous years were probed to locate uniform river bottom gradients that would provide optimum surfaces for insonification. Two steel pipes were set into the river bottom on each side of the river, onto which the transducer frames were guided by side-mounted steel sleeves. Counting ranges were initially set to 60 ft. Weirs prevented salmon passage inshore of the transducer on each bank. Transducers were moved inshore or offshore and counting ranges were adjusted as required by fluctuating water levels.

During the 1989 season 1981-model sonar counters were used on both banks of the Anvik River. These model counters divided the counting range in 16 sectors. Sectors were consecutively numbered from the west to east bank. Therefore, sectors 1 - 16 were associated with the west bank counter while sectors 17 - 32 were associated with the east bank counter. Sector number 1 and 32 corresponded to the near-shore sector on the west and east bank, respectively. Sector counts missing as a result of debris or printer malfunction were estimated by averaging the counts in the same sector for the hour before and after the sector count in question. When salmon were not counted for a large portion of a day, counts were estimated for that time period based on the mean proportion of the corrected salmon counts for that period for the day before and after the day of the data omission. Estimated partial daily counts were distributed by sector based on the count-distribution pattern of the portion of the day when counts were recorded. Estimated counts were distributed by hour based on the distribution pattern of the corrected counts for the day before and after the day of the data omission which had full 24-h counts. When counting was not conducted for a full day, the salmon passage for that day was estimated as the mean of the salmon passage for the day before and after the day for which which sonar counts were not available. The estimated daily counts were distributed by hour and sector based on the distribution patterns of the corrected counts of the day before and after the missing count day which had full 24-h counts.

Corrected period counts were totaled for each day, for each bank using an electronic calculator. Since summer chum salmon greatly outnumber chinook and pink salmon, and the counters do not distinguish between species of salmon, all sonar counts were attributed to summer chum salmon passage. A separate escapement estimate for chinook salmon was obtained by aerial survey. During the 1989 season pink salmon were not observed either from the tower or in beach seine samples.

Each sonar counter was calibrated five times daily by observing fish passage with an oscilloscope for an approximate 15-minute period. Five daily calibration times were deemed adequate to monitor the diel timing pattern of the salmon migration. Calibrations were normally conducted during the hours of 0400, 0800, 1300, 1800, and 2400. However, during the initial and last days of the project when fish passage was low, calibrations were conducted during the hours of 0600, 1000, 1400, 1800, and 2400.

Salmon passing through the sonar beam produce a distinct oscilloscope trace. Sonar and oscilloscope counts for each calibration period were related in the formula: Q=SS/SC, where SS = side scan sonar counts, and SC = oscilloscope counts. The fish velocity control setting was adjusted if Q varied from 1.0 by 15% during the 1300 (or 1400) and the 2400 calibration hours and when the ratio varied from 1.0 by more than 25% during all other calibration hours. The existing fish velocity setting was multiplied by Q to obtain the correct new setting. After adjustments were made to the sonar unit an additional 15-minute calibration was made to ensure that the ratio was within accepted limits and to initialize the counting period. A record was kept of all adjustments to the sonar equipment. Attempts were also made to visually enumerate fish passage from 10 ft counting towers during sonar calibration times as a further check on sonar accuracy. Polaroid sunglasses were worn to reduce water surface glare. However, high water turbidity during the 1989 field season precluded the visual enumeration of salmon from both banks for most calibration times. Additionally, attempts to visually enumerate salmon during calibration times were discontinued from the west bank when it became apparent that the presence of the observer on the tower interfered with the normal passage of salmon past the sonar site.

Daily sonar counts were adjusted based on bank-specific, period calibration data. Calibration periods were defined by the time of each calibration. For each bank, unadjusted sonar counts for each period were multiplied by the periodic adjustment factor, calculated as the sum of the two oscilloscope counts associated with the calibrations which defined the period divided by the sum of the two associated sonar counts for that period. The resulting corrected sonar counts for each period within a day were summed, yielding the estimated summer chum salmon passage for that day for that bank. The daily adjustment factor was found by dividing the daily corrected counts by the sonar counts. The daily passage of salmon was determined by summing the daily bank estimates. Mean and standard deviation of date of passage were calculated following the method presented by Mundy (1982).

Unadjusted sonar counts by hour and sector were corrected using the periodic bank-specific adjustment factor for each day for each bank in order to determine the temporal and spatial segregation of the summer chum salmon run. Periods used for the comparison of hourly passage data were defined by the four time period which defined the early, early middle, late middle and late time strata for age-sex-size sampling goals. Each terminal stratum was defined by an approximate 2-week interval with the two middle strata defined by a 1-week period: June 16 -

June 30; July 1 - 7; July 8 - 15 and July 16 - 30. These periods were determined preseason, based on historic run timing data, in an attempt to sample the escapement in proportion to the total run.

Water depth profile at each bank-specific sonar site was measured at 3 m intervals from established headpins across the width of the river by probing with a pole marked in 1 cm increments. River profile data was collected four times during the season. Climatological data were collected at noon each day at the campsite. Relative river depth was monitored by staff gauge marked in 0.01 ft increments. Changes in water depth was converted to cm and presented as negative or positive increments from the initial reading of 0.0 cm. Water temperature was measured in degrees centigrade near shore at a depth of about 0.5 m. Daily maximum and minimum air temperatures were recorded in degrees centigrade. Subjective notes were kept by the crew describing wind speed and direction, cloud cover, and precipitation.

A beach seine (100 ft long, 66 meshes deep, 2.5 in mesh) was set near the sonar site to capture chum and chinook salmon for age, sex, and size measurements. All captured salmon were enumerated by species and sex. Chum and chinook salmon were placed in a holding pen, identified by sex, and measured from mid-eye to fork of tail in mm. One scale was taken for age determination from chum salmon. Three scales were taken from each chinook salmon sampled for determination of age and stock-of-origin analysis. Scales were removed from an area posterior to the base of the dorsal fin and above the lateral line on the left side of the fish. The adipose fin was clipped on each fish before release to prevent resampling. Additionally, chinook salmon carcasses were sampled in August to supplement the beach seine sample. Scale samples were later pressed on acetate cards and the resulting impressions viewed on a microfiche reader for age determination. Sample size goals were based on 95% precision with a 10% accuracy for each time stratum. A sample size of 150 fish per stratum (early, early middle, late middle, and late) was needed for chum salmon. This sample size accounts for a 15% unageable rate when 1 scale per fish is collected. A sample size of 400 chinook salmon per stratum (entire season) was deemed necessary for the scale-pattern analysis baseline for the Anvik River stock. The maximum sample size needed to describe the age composition of the chinook salmon population of the Anvik River, considering only one stratum, with 95% precision and 10% accuracy is 150.

RESULTS AND DISCUSSION

Two sonar counters were operated on the Anvik River from June 18 through July 26 at the same sites used in previous years (Figure 2). The east bank transducer was located along a cutbank approximately 150 m above the field camp site. Initial placement of the east bank transducer was approximately 1.0 m offshore and at a depth of 50 cm. The west bank transducer was located along a gradually sloping gravel bar, approximately 60 m downstream from the east bank site. Initial placement of the west bank transducer was approximately 15.5 m offshore and at a depth of 25 cm. Due to river level fluctuations offshore placement of the transducer as well as water depth at the transducer varied throughout the season. An approximate 10 m portion of the river transect was not insonified in the center of the channel on 25 June. The portion of the river transect which was not insonified on July 6, 15, and 26 varied slightly ranging from 20 to 22 m (Figures 3 and 4). Similar river insonification was achieved during the initial placement of the transducers on June 18 and throughout the season. River transect data collected on June 25, July 6, 15 and 22 indicates that the bottom gradient was relatively smooth on the west bank, with no major obstructions to the sonar beam (Figure 3). Bottom gradient of the east bank was smooth for the first 9 m to the bottom of a trough (Figure 4). Although the ridge which existed beyond the trough appears to be a major obstruction to the sonar beam (Figure 4), the actual obstruction did not interfere with salmon counts. The discrepancy between the actual versus the observed obstruction can be explained by the placement of the river profile transect in relation to the insonified zone. River transect data was collected immediately downstream of the sonar beam where the relief of the trough was more acute than within the insonified zone. Additionally, the rock-inhibiting feature on the 1981-model sonar counters eliminated most of the ridge from the counting range of the insonified zone.

River width data collected in conjunction with the transect profiles varied from a high on June 25 at the east and west bank sonar sites of 78 m and 87 m, respectively, to a low recorded on July 6 of 68 m and 66 m, respectively. Maximum river depth observed during the collection of river profile data was 210 cm recorded on 3 of the four sets of profile data. Overall maximum river width and river depth during the field season most likely occurred during the first full day of field operations, June 17. River water level dropped approximately 67 cm between June 17 and June 25 (Figure 5). River water level declined approximately 120 cm in a fairly consistent and regular manner from June 17 through July 9. However, heavy rains in mid-July caused a dramatic increase in river level of approximately 110 cm in three days. This freshet temporarily disrupted sonar counting operations from July 15 - 17. Water temperature ranged from a low of 9.0 C on June 17 and 18 to a high of 18.5 C on July 3 and 5, while air temperature ranged from a low daily minimum of 3 C on July 16 to a high daily maximum of 31 C observed on June 30 and July 3 (Figure 5).

The adjusted escapement count for the period June 18 through July 26 was 636,906 summer chum salmon (Table 1). As in 1988, the four-day period June 29 through July 2 accounted for the greatest salmon passage, 22%. However, unlike the 1988 migration, the 1989 chum salmon migration was more evenly distributed throughout the duration of the run. Escapement timing appeared to be average, as it had been in 1979 (Figure 6). Mean date of run passage was 7 July, with a standard deviation of 7.44 days.

In response to an observed above average summer chum salmon run special restricted mesh size fishing periods were implemented for the commercial fishery prior to the first unrestricted mesh size fishing periods in District 1 and 2, statistical areas 334-10 and 334-20, respectively (Figure 1). Due to a large abundance of summer chum salmon additional fishing periods with restricted mesh size of 6 in were allowed on June 24-25 in District 1 and June 27 in District 2. The next regular scheduled period in District 2 was not allowed in order to reassess run strength. However, evidence of a continued strong run prompted the implementation of a 6-h period on June 29 in District 2. After this period the regular fishing schedule, with 12-h periods, was maintained throughout the remainder of the summer chum salmon season.

Buklis (1982a) expanded the season escapement estimates for 1972 through 1978, making it possible to more directly compare visual count estimates to more recent annual sonar count estimates (Figure 7). The 1989 escapement estimate of 636,906 summer chum salmon was 40% less than the parent year escapement in 1985, was approximately 31% above the escapement objective of 487,000 fish, and was also 2% below the long term (1972-1988) average of 647,000 fish. However, the 1989 District 1, 2, and 3 commercial harvest of 899,171 summer chum salmon was more than double the corresponding 1985 harvest on the parent year.

A total of 45.07 hours of sonar calibration were conducted over a 38-day period at the west bank site. Sonar accuracy (sonar count/oscilloscope count) averaged 1.01 (Table 2). Sonar accuracy averaged 1.02 for 41.25 hours of oscilloscope calibration at the east bank site over a period of 39 days (Table 2). High water and associated high turbidity precluded the use of tower counts in checking the accuracy of the counters throughout the season.

Temporal distribution of the east and west bank adjusted sonar counts by hour (Appendix A.1 and A.2, respectively) indicates a distinct diel pattern of salmon passage (Figure 8). Based upon adjusted counts salmon passage was lowest during the hours of 0800-2000 (averaging 3.1% of total daily passage per hour) and greatest during 2400-0700 (averaging 5.9% of total daily passage per hour). This pattern was relatively consistent throughout the season and very similar to the 1988 temporal distribution pattern of the migration (Sandone 1989).

Spatial distribution of the adjusted sonar counts by sector (Figure 9) indicates that most of the salmon passage occurred near shore on the west bank, sonar sectors 2, 3, and 4 (Appendix A.3). Most of the salmon passage associated with the east bank also occurred in the sonar sectors near shore, sectors number 29, 30, and 31 (Appendix A.4). The sonar sectors nearest the shoreline of each bank, sonar sectors 1 (west bank) and 32 (east bank) were low probably due to the salmon avoiding the nearby weir and transducer. Overall, over 78% of the total adjusted sonar counts were associated with the west bank. West bank sectors 2 through 4 accounted for 58% of all adjusted sonar counts, while east bank sectors 29 through 31 accounted for 12%. The remaining 30% of the counts were distributed across the other 26 sonar counting sectors.

Twenty (20) beach seine sets were made from June 27 to July 22. A total of 680 chum salmon were captured (Appendix A.5). No chinook or pink salmon were captured by beach seine. However, 412 chinook salmon carcass samples were collected by boat survey in August. Of the 622 chum salmon sampled for age-sex-size data, 588 (95%) later proved to have ageable scales. Age and sex composition of the escapement passing the sonar site varied by time in a consistent manner (Figure 10). Of the four sampling strata, age-5 chum salmon dominated the two early strata, while age-4 dominated the final stratum. Male chum salmon dominated during the first stratum. Female chum salmon dominated during the last two strata. Age composition of the escapement, weighted by strata escapement counts, was 1.2% age 3, 37.9% age 4, 60.7% age 5, and 0.1% age 6 (Appendix A.6). Age-5 chum salmon dominated the escapement in 1972, 1976, 1981, 1986, and 1989, but in all other years since 1972 the 4-year-old age class has dominated (Figure 11). Female chum salmon accounted for 65.6% of the 1989 escapement to the Anvik River. Females have contributed more than 50% to the escapement sample of summer chum salmon in 15 of the 18 years of record.

Age and sex composition of the District 1 commercial catch in 1989 varied by mesh size and progression of the run. The age composition of the District 1 commercial catch and the Anvik River escapement sample were similar in 1989, as has been observed in previous years. The preliminary age-class composition estimate of the total District 1 summer chum salmon harvest was 0.1% age 3, 31.4% age 4, 67.9% age 5, and 0.6% age 6 (T. Lingneau, Alaska Department of Fish and Game, Anchorage, personal communication). However, unlike the sex composition of the 1989 Anvik River escapement, the sex composition of the 1989 District 1 commercial catch of summer chum salmon was dominated by males. Male chum salmon accounted for 55.6% of the District 1 harvest (T. Lingneau, Alaska Department of Fish and Game, Anchorage, personal communication). The difference in the sex composition between the District 1 harvest and Anvik River escapement is thought to occur because of the selective nature of the gill nets used in the harvest and the larger size of the male chum salmon.

Of the 418 chinook salmon sampled for age-sex-size data, 381 (92%) proved to have ageable scales. Age composition was 4.5% age 4, 49.1% age 5, 43.6% age 6, and 2.9% age 7 (Figure 12). Females accounted for 40.7% of the sample (Appendix A.7). These age compositions do not correspond closely with the age composition of the District 1 and 2 commercial harvest, which was approximately 4.7% age 4, 33.7% age 5, 51.7% age 6, 9.0% age 7, and 0.9% age 8 (T. Lingnau, Alaska Department of Fish and Game, Anchorage, personal communication). This discrepancy in age class composition of the escapement and harvest was most likely due to the selectivity of the restricted and unrestricted gear types, the magnitude of the catch attributed to each gear type, and the various chinook stocks present in the river during the harvest period. The percentage of females in the escapement sample was near the mid-point of the overall 20% to 63% range observed in previous years for the Anvik River.

An aerial survey of the Anvik River (including Otter Creek, Beaver Creek, Swift River, and Yellow River) was flown on 16 July under poor survey conditions. A total of 442 chinook salmon were enumerated. Chum salmon were not enumerated since the time of the survey was well past peak spawning. The count of 268 chinook salmon in the mainstem Anvik River between the Yellow River and McDonald Creek did not achieve the aerial survey escapement objective of 300 to 500 chinook salmon for this index area.

CONCLUSIONS AND RECOMMENDATIONS

Escapement to the Anvik River, estimated by side-scanning sonar, was 636,906 summer chum salmon in 1989. Although this escapement passage was very close to the long-term escapement level it was 31% above the sonar count escapement objective of 487,000 fish for this river. Although the chinook salmon aerial survey escapement objective was not achieved, the aerial survey of the Anvik River was conducted under poor conditions, and therefore represents a minimal escapement estimate to this system. Actual escapement was probably much greater.

Subjective assessment by the crew and the sport fishing guide on the river, and the sampling success of the carcass survey crew indicates that the chinook escapement may have been similar to the 1988 level.

Presently, stock identification data is not available for the Yukon River summer chum salmon fisheries. Additionally, stock-specific run timing through these fisheries is not known. However, in 1989 an attempt was made to obtain the commercial summer chum harvest from among many stocks by distributing the commercial fishing effort in the lower river fishery throughout the duration of the chum salmon run. Commercial fishing was allowed during 8 and 7 directed chum salmon openings in District 1 and 2, respectively, from June 13 through July 14. The total District 1 and 2 summer chum salmon harvest was 891,593 fish.

Summer chum salmon run timing at the lower Yukon River set gill net test fishery (mile 20), at the Yukon River sonar site (mile 123), and at the Anvik River sonar site (mile 365) can be compared to provide a qualitative assessment of summer chum salmon timing through the lower river fisheries (Figure 13). The mean dates of passage at each of these three sites in 1989 was June 21, June 27, and July 7, respectively. The similarity in the standard deviation of the mean day of passage at the test fish site and Yukon River sonar, 9.01 and 9.07, respectively, indicates that the dispersion of the migration through time are very similar passing these two sites. Based on these data, the calculated lag time between the lower river test fishery and the Yukon River sonar passage in 1989 was 6 days. However, salmon migration time between the test fishery and the sonar has been thought to be approximately 3 days. The difference between observed and expected migration time based on the mean day of passage between these two locations can be partially explained variable test net efficiency dependent on the number of catchable salmon passing during a 12-hr period and the catch of small chum salmon in the 5.5 in mesh gill nets used by the Yukon River sonar test fishing program late in the migration which were not caught by the 6.0 in lower river test nets. The net effect of these factors may tend to move the mean day of passage earlier for the lower Yukon River test fish passage and later for the Yukon River sonar passage, and possibly account for the observed versus expected migration time.

Based on mean day of salmon passage and the 345-mile distance from the Yukon River test fish site to the Anvik River sonar site, the calculated mean swimming speed of Anvik River chum salmon was 21.5 miles per day (mpd) in 1989. This was very similar to swimming speeds of 20.3 mpd in 1987 and 24.6 mpd in 1988 calculated for this stock by Buklis (1987) and Sandone (1989), respectively.

The method of deploying sonar transducers on the Anvik River, first used in 1986, was once again effective in 1989. The method should perform well even in very high water conditions, as were encountered in 1985. The schedule of sonar calibration times at the Anvik River was altered in 1989 to reflect the need for more sonar calibrations during times of peak salmon passage. Additionally, daily adjustment factors were replaced with period adjustment factors based on the time schedule of sonar calibrations. Period adjustment factors, based on the diel pattern of salmon movement, are more specific to a discrete set of sonar counts, and probably improve the accuracy of the daily estimate.

The addition of a third crew member on the Anvik River sonar project in 1989 resulted in improved project data quality, provided for better employee working conditions, and facilitated project logistics. The additional cost to the project was insignificant because the expansion of the crew to three people negated the need for overtime.

Because of the improvement in working conditions and quality of data collected, all recommendations suggested by Sandone (1989) which were implemented during the 1989 season should continue. Additionally, because the crew is working with 16-sector sonar counters rather than the 12-sector counter, the amount of calculations necessary to derive the daily passage estimate has increased by at least 33%. Therefore, the use of a portable computer to generate the daily estimate is warranted. The inseason use of a computer will also facilitate post season analysis of project data. If available, it is recommended that a portable computer be assigned to the Anvik sonar project during the field season.

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Table 1. Anvik River summer chum salmon sonar counts by date, June 20 - July 26, 1989.[a]

	West Bank				East Bank				Entire River			
Date	Raw Daily	Adjust Factor[b]	Correct Daily	Percent of Daily Total	Raw Daily	Adjust Factor[b]	Correct Daily	Percent of Daily Total	Daily Count	Season Count	Daily Prop.	Season Prop.
20-Jun	0		0	0.0	148	1.10[c]	162	100.0	162	162	0.0003	0.0003
21-Jun	325	1.08[c]	351	70.6	134	1.10[c]	146	29.4	497	659	0.0008	0.0010
22-Jun	1,565	1.08[c]	1,691	75.4	504	1.10[c]	553	24.6	2,244	2,903	0.0035	0.0046
23-Jun	4,348	1.08[c]	4,696	95.5	202	1.10[c]	223	4.5	4,919	7,822	0.0077	0.0123
24-Jun	4,306	1.08	4,638	88.2	561	1.10[c]	620	11.8	5,258	13,080	0.0083	0.0205
25-Jun	7,005	0.99	6,936	95.4	299	1.10[c]	332	4.6	7,268	20,348	0.0114	0.0319
26-Jun	5,687	1.23	6,999	95.2	323	1.10	354	4.8	7,353	27,701	0.0115	0.0435
27-Jun	16,711	1.00	16,745	94.1	953	1.10	1,047	5.9	17,792	45,493	0.0279	0.0714
28-Jun	23,981	0.88	21,049	97.3	529	1.10	583	2.7	21,632	67,125	0.0340	0.1054
29-Jun	37,603	0.85	31,799	94.8	1,574	1.10	1,734	5.2	33,533	100,658	0.0526	0.1580
30-Jun	24,770	1.02	25,179	69.5	9,554	1.16	11,049	30.5	36,228	136,886	0.0569	0.2149
01-Jul	22,848	1.08	24,592	65.6	12,340	1.04	12,868	34.4	37,460	174,346	0.0588	0.2737
02-Jul	23,666	1.05	24,821	73.6	8,225	1.08	8,922	26.4	33,743	208,089	0.0530	0.3267
03-Jul	21,013	1.00	21,039	72.5	6,726	1.19	7,994	27.5	29,033	237,122	0.0456	0.3723
04-Jul	16,648	1.02	16,980	70.6	6,154	1.15	7,078	29.4	24,058	261,180	0.0378	0.4101
05-Jul	14,573	1.12	16,305	63.2	9,062	1.05	9,492	36.8	25,797	286,977	0.0405	0.4506
06-Jul	16,011	1.04	16,659	73.5	6,457	0.93	6,009	26.5	22,668	309,645	0.0356	0.4862
07-Jul	18,691	0.97	18,121	75.8	5,771	1.00	5,786	24.2	23,907	333,552	0.0375	0.5237
08-Jul	19,334	1.05	20,370	72.2	8,173	0.96	7,862	27.8	28,232	361,784	0.0443	0.5680
09-Jul	19,392	1.08	20,936	75.4	7,113	0.96	6,827	24.6	27,763	389,547	0.0436	0.6116
10-Jul	14,017	1.04	14,623	70.3	6,185	1.00	6,167	29.7	20,790	410,337	0.0326	0.6443
11-Jul	16,578	1.02	16,879	77.4	5,062	0.97	4,925	22.6	21,804	432,141	0.0342	0.6785
12-Jul	21,082	1.00	21,068	73.3	8,360	0.92	7,669	26.7	28,737	460,878	0.0451	0.7236
13-Jul	25,136	0.98	24,641	72.9	10,464	0.88	9,180	27.1	33,821	494,699	0.0531	0.7767
14-Jul	21,933	0.94	20,555	76.5	7,338	0.86	6,301	23.5	26,856	521,555	0.0422	0.8189
15-Jul	20,405[d]	0.92[e]	26,014[f]	85.0	4,432	1.04	4,588	15.0	30,602	552,157	0.0480	0.8669
16-Jul	-[g]	-[g]	15,505[h]	87.1	-[g]	-[g]	2,298[h]	12.9	17,803	569,960	0.0280	0.8949
17-Jul	5,290	0.94	4,995	99.8	4[i]	-[g]	8[k]	0.2	5,003	574,963	0.0079	0.9027
18-Jul	10,791	0.96	10,329	98.7	135	0.97	131	1.3	10,460	585,423	0.0164	0.9192
19-Jul	8,765	1.01	8,857	88.3	1,227	0.96	1,178	11.7	10,035	595,458	0.0158	0.9349
20-Jul	8,251	1.13	9,292	85.5	1,905	0.83	1,580	14.5	10,872	606,330	0.0171	0.9520
21-Jul	6,297	1.12	7,033	84.7	1,376	0.92	1,266	15.3	8,299	614,629	0.0130	0.9650
22-Jul	4,724	0.99	4,664	88.0	608	1.05	636	12.0	5,300	619,929	0.0083	0.9733
23-Jul	4,815	1.02	4,902	89.3	677	0.87[c]	588	10.7	5,490	625,419	0.0086	0.9820
24-Jul	2,373	1.21	2,880	85.6	558	0.87[c]	486	14.4	3,366	628,785	0.0053	0.9872
25-Jul	3,165	0.99	3,126	81.7	803	0.87[c]	701	18.3	3,827	632,612	0.0060	0.9933
26-Jul	3,436	1.00	3,446	80.3	977	0.87[c]	848	19.7	4,294	636,906	0.0067	1.0000

[a] Counts were initiated on June 18. No fish were counted on June 18 and 19.
[b] Adjustment factor is the ratio of the corrected daily sonar counts to the raw sonar counts.
[c] Sonar calibration data pooled on these days due to the low numbers of fish counted during calibration periods.
[d] Raw count data are for the period 0000-1900; data unavailable for the period 1900-2400.
[e] Pertains to the period 0000-1900.
[f] Includes the estimated salmon count for the period 1900-2400. This estimate was derived by dividing the corrected count for the period 0000-1900 by the mean proportion of the west bank counts recorded for that period on July 14 and 17.
[g] Data unavailable.
[h] Estimated total daily count; calculated as the mean of the daily counts of June 15 and 17.
[i] Raw count data are for the period 1300-2400; data unavailable for the period 0000-1300.
[k] Includes the estimated salmon count for the period 0000-1300. This estimate was derived by dividing the corrected count for the period 1300-2400 by the mean proportion of the west bank counts recorded for that period on July 15 and 18.

Table 2. Sonar and oscilloscope counts of salmon at the Anvik River east and west bank sites, 1989.

	West Bank Sonar Site				East Bank Sonar Site			
Date	Hours Count	Sonar Count	Scope Count	Sonar/ Scope	Hours Count	Sonar Count	Scope Count	Sonar/ Scope
18-Jun	0.00	0	0	0.00	0.25	0	0	0.00
19-Jun	0.50	0	0	0.00	0.50	0	0	0.00
20-Jun	1.00	0	0	0.00	0.75	0	0	0.00
21-Jun	1.50	0	0	0.00	1.25	0	0	0.00
22-Jun	1.25	28	31	0.90	1.25	1	1	1.00
23-Jun	1.50	114	116	0.98	1.25	0	0	0.00
24-Jun	1.25	174	181	0.96	1.25	4	3	1.33
25-Jun	1.25	210	215	0.98	0.75	0	0	0.00
26-Jun	1.75	183	232	0.79	0.50	5	5	1.00
27-Jun	1.25	537	508	1.06	1.00	51	49	1.04
28-Jun	1.50	1,140	1,056	1.08	1.25	44	46	0.96
29-Jun	1.17	1,694	1,394	1.22	1.00	50	63	0.79
30-Jun	1.00	992	1,018	0.97	1.50	291	331	0.88
01-Jul	1.33	1,023	1,097	0.93	1.33	489	494	0.99
02-Jul	1.33	620	666	0.93	1.25	443	477	0.93
03-Jul	1.33	866	878	0.99	1.25	220	249	0.88
04-Jul	0.25	338	340	0.99	0.42	130	142	0.92
05-Jul	1.50	557	643	0.87	1.50	402	391	1.03
06-Jul	1.25	600	634	0.95	1.50	394	372	1.06
07-Jul	1.25	894	869	1.03	1.25	194	198	0.98
08-Jul	1.25	876	909	0.96	1.25	370	359	1.03
09-Jul	1.25	853	936	0.91	1.25	344	316	1.09
10-Jul	1.25	592	624	0.95	1.25	535	547	0.98
11-Jul	1.25	831	852	0.98	1.25	257	251	1.02
12-Jul	1.25	1,046	1,058	0.99	1.25	282	256	1.10
13-Jul	1.25	1,289	1,238	1.04	1.25	347	307	1.13
14-Jul	1.25	1,023	1,003	1.02	1.50	433	335	1.29
15-Jul	1.50	1,373	1,207	1.14	1.25	254	262	0.97
16-Jul	0.50	296	294	1.01[a]	0.25	5	6	0.83[a]
17-Jul	1.58	380	357	1.06	0.75	1	1	1.00[a]
18-Jul	1.33	714	647	1.10	1.25	0	1	0.00
19-Jul	1.42	469	481	0.98	1.50	29	28	1.04
20-Jul	1.25	340	298	1.14	1.25	100	85	1.18
21-Jul	1.33	428	491	0.87	1.25	64	58	1.10
22-Jul	1.75	329	323	1.02	1.25	32	30	1.07
23-Jul	1.25	280	275	1.02	1.25	17	21	0.81
24-Jul	1.25	81	102	0.79	1.25	24	25	0.96
25-Jul	1.25	186	174	1.07	1.25	22	18	1.22
26-Jul	1.50	193	194	0.99	1.50	70	48	1.46
Total	45.07	21,549	21,341	1.01	41.25	5,904	5,775	1.02

[a]Counts of salmon distrupted due to the disturbance of the sonar equipment by high water.

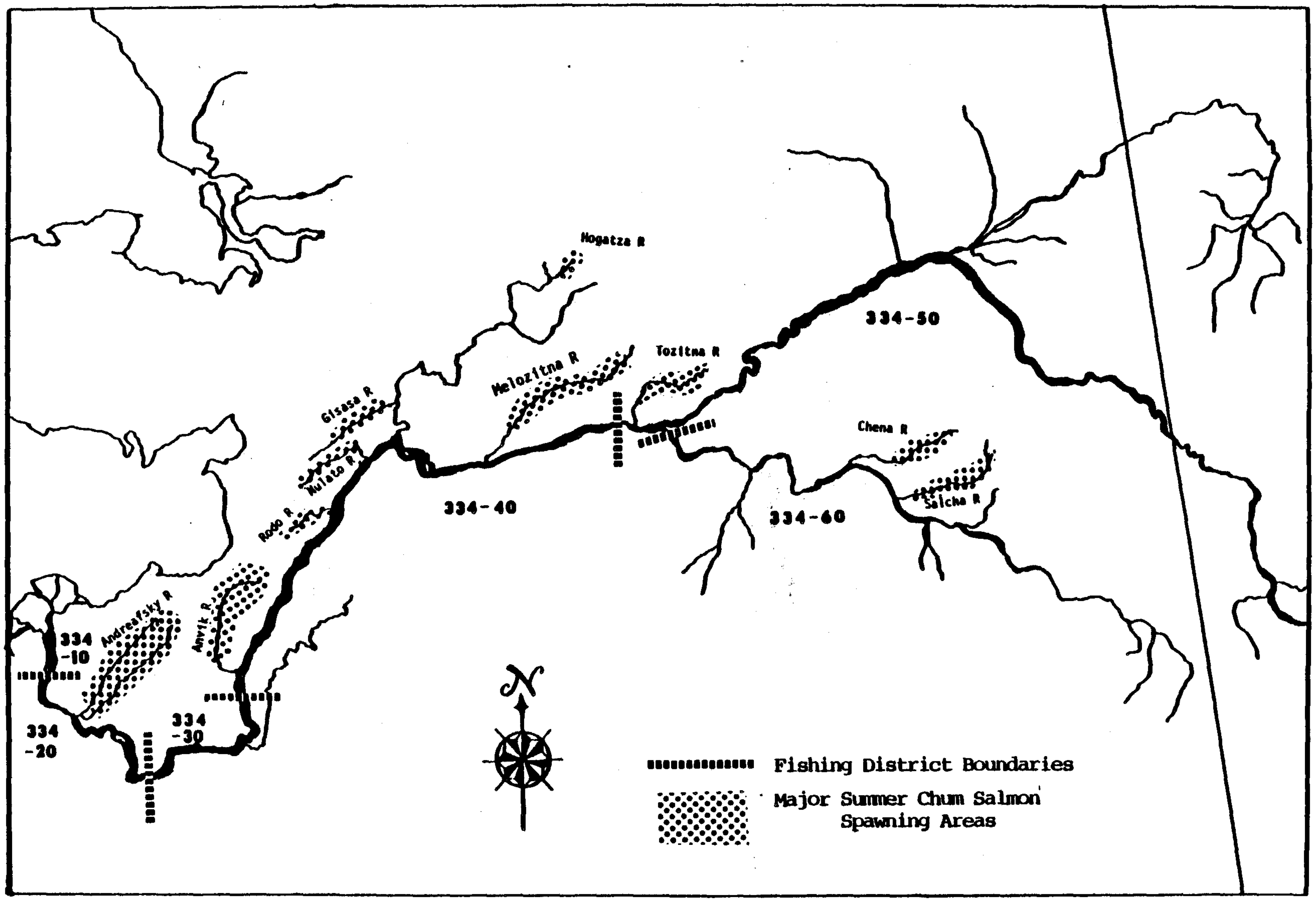

Figure 1. Map of the Yukon River, showing fishing districts and major summer chum salmon spawning areas.

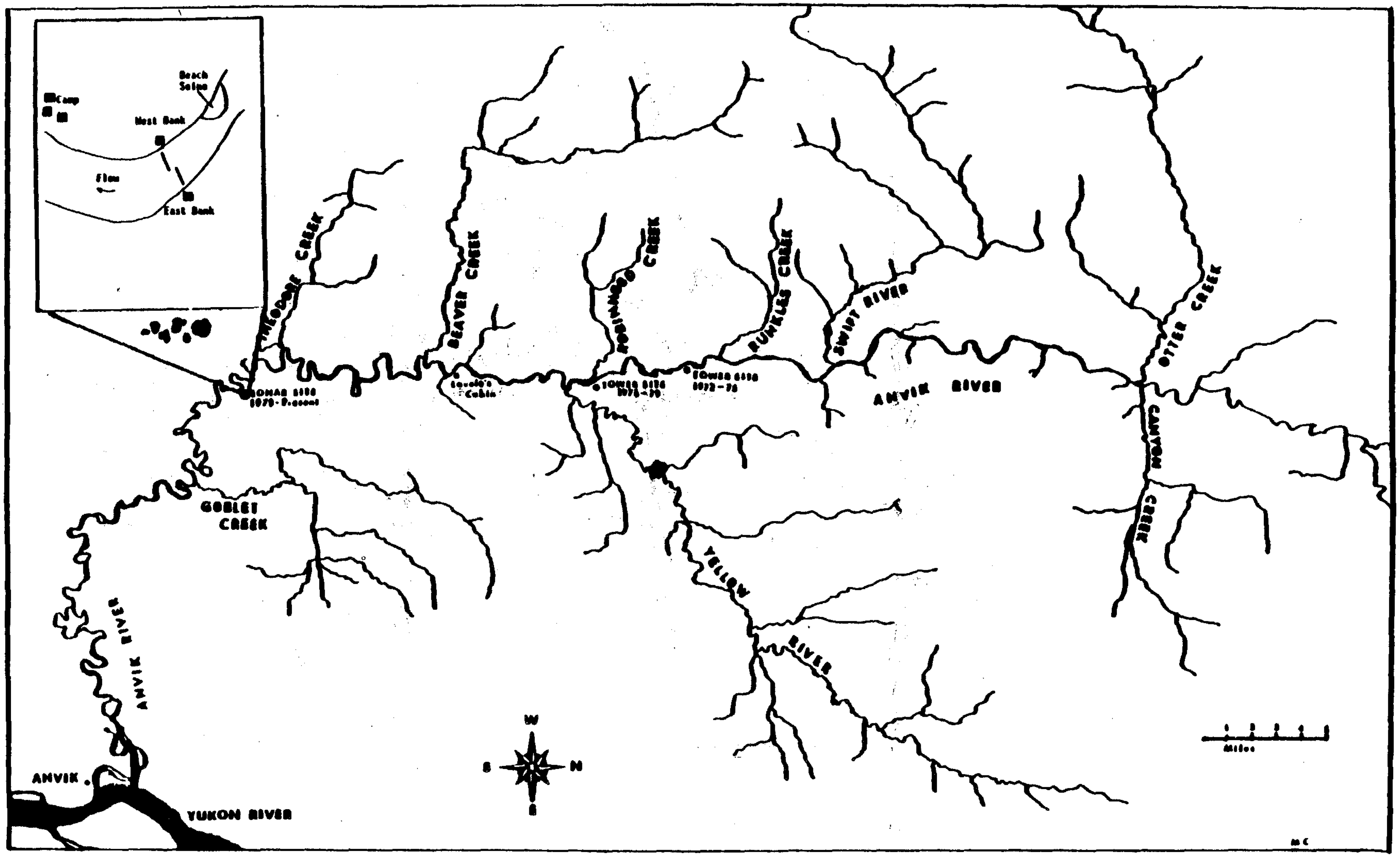

Figure 2. Map of the Anvik River with schematic sketch of the sonar site camp area (inset).

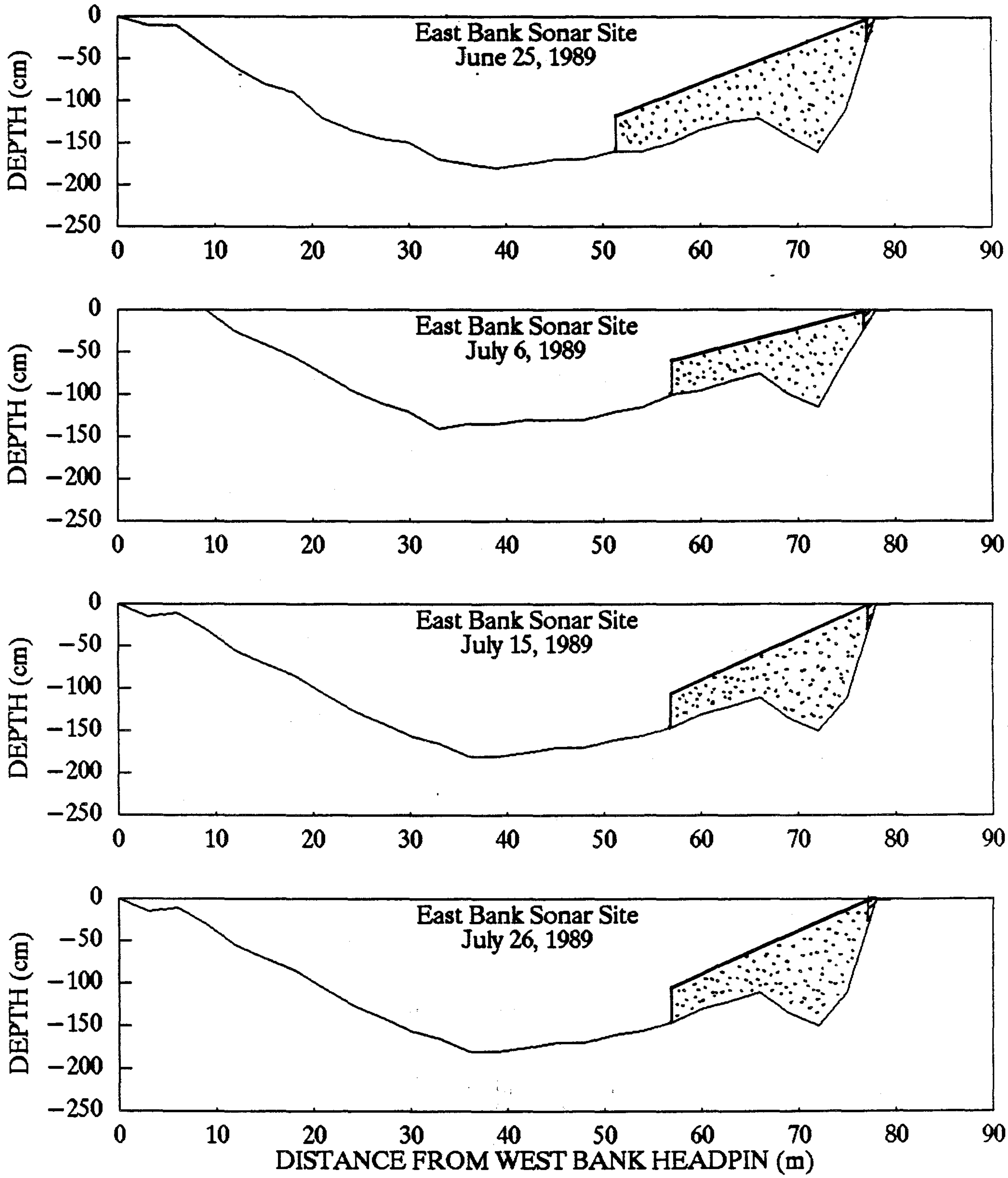

Figure 3. Anvik River depth profiles, east bank sonar site, 25 June, 6, 15, and 26 July, 1989. Stippled areas show approximate range of insonification. Weirs are indicated with cross hatching.

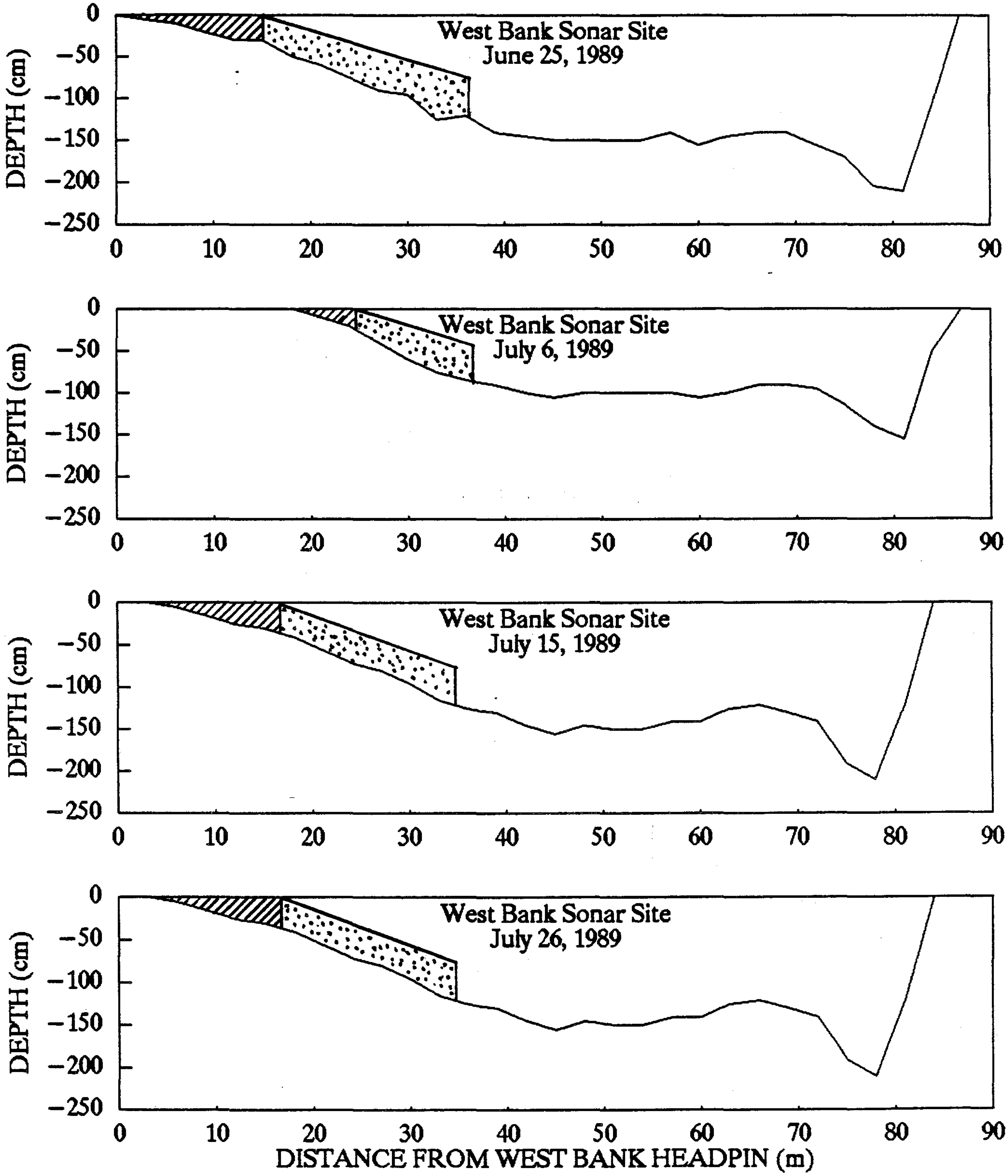

Figure 4. Anvik River depth profiles, west bank sonar site, 25 June, 6, 15, and 26 July, 1989. Stippled areas show approximate range of insonification. Weirs are indicated with cross hatching.

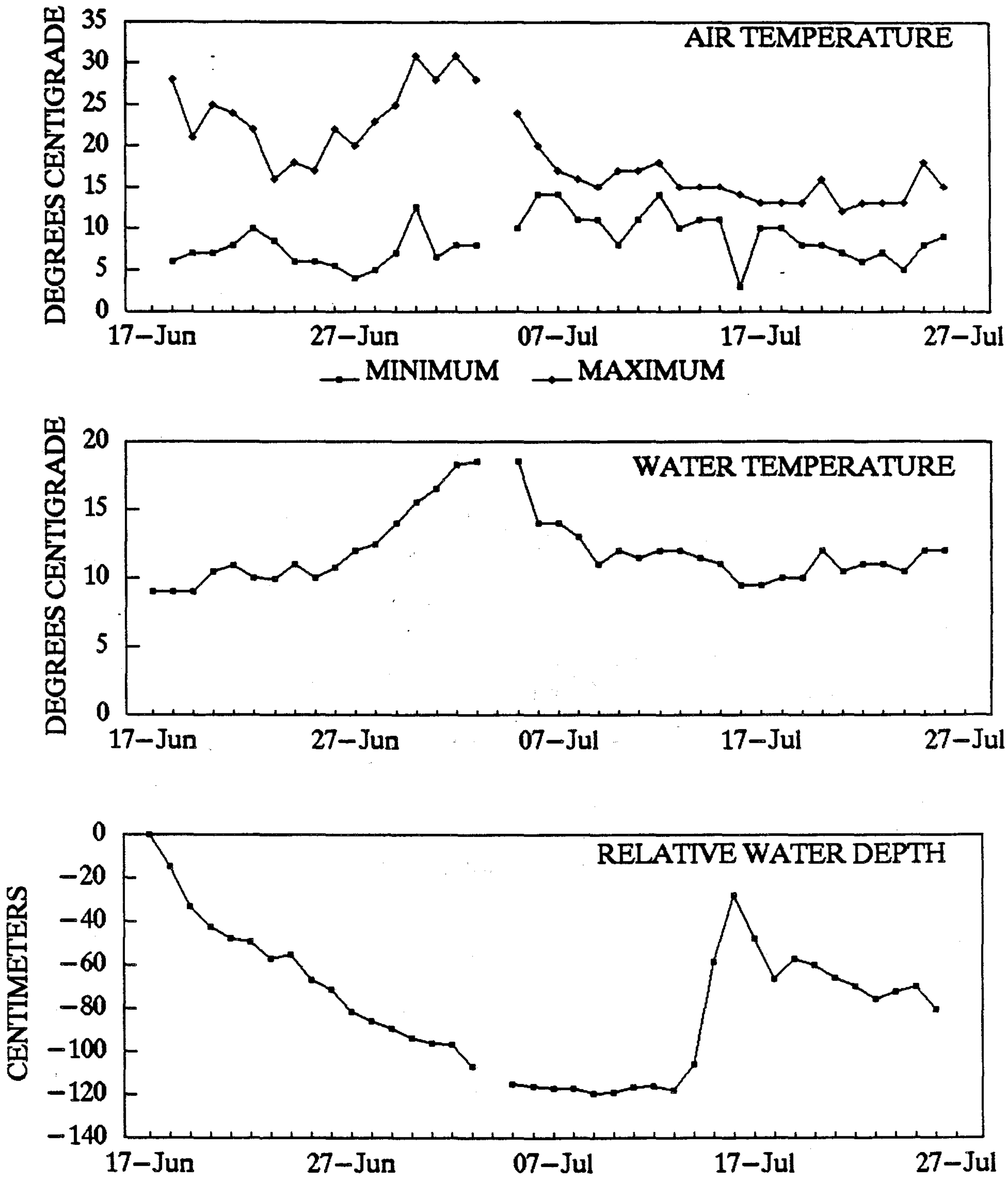

Figure 5. Daily minimum and maximum air temperatures and instantaneous water temperature and relative water depth measured at noon daily at the Anvik River sonar site, 1989.

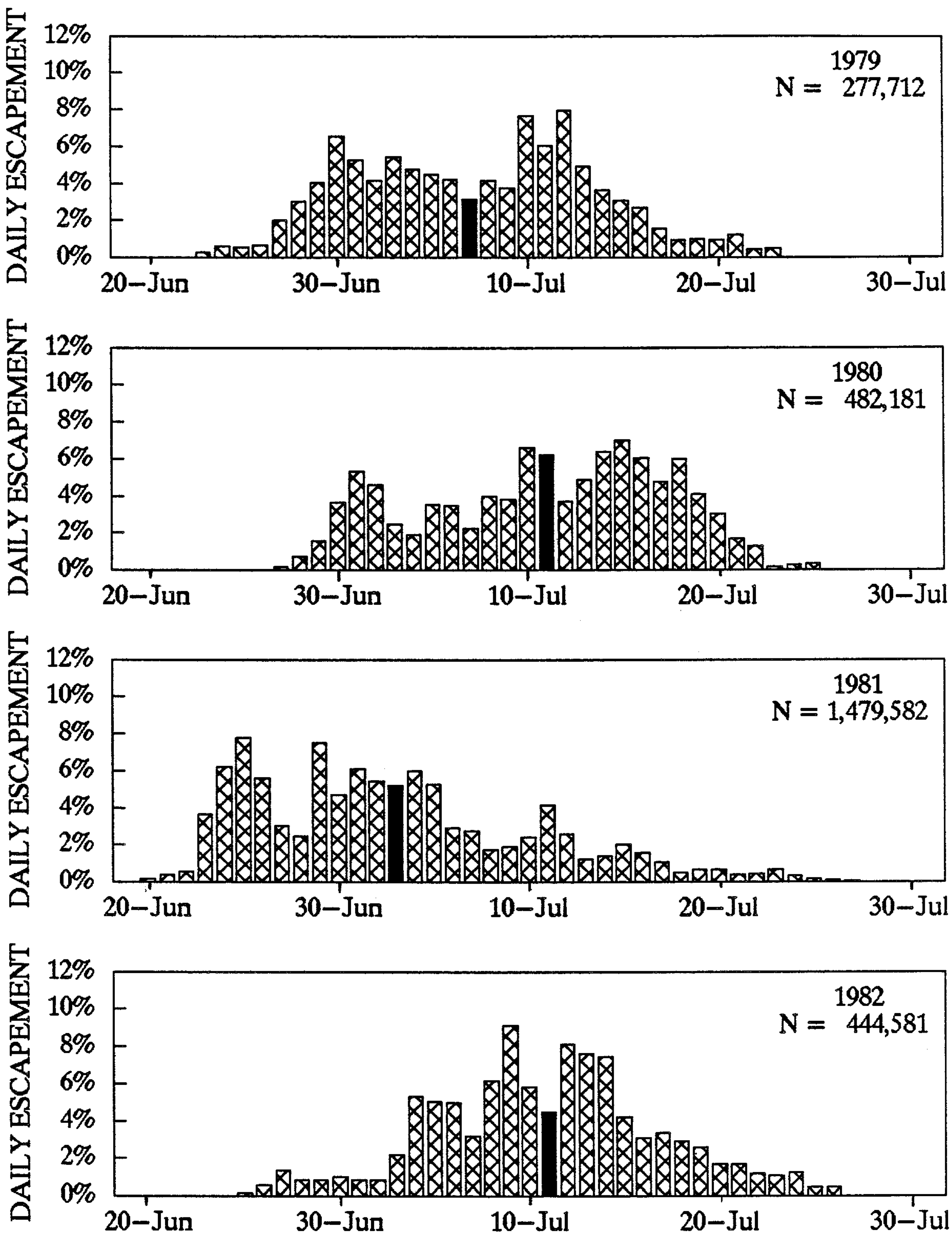

Figure 6. Anvik River corrected sonar counts of summer chum salmon passage by day, 1979-1989 (N = total). Mean date of run passage is indicated by shaded bar,

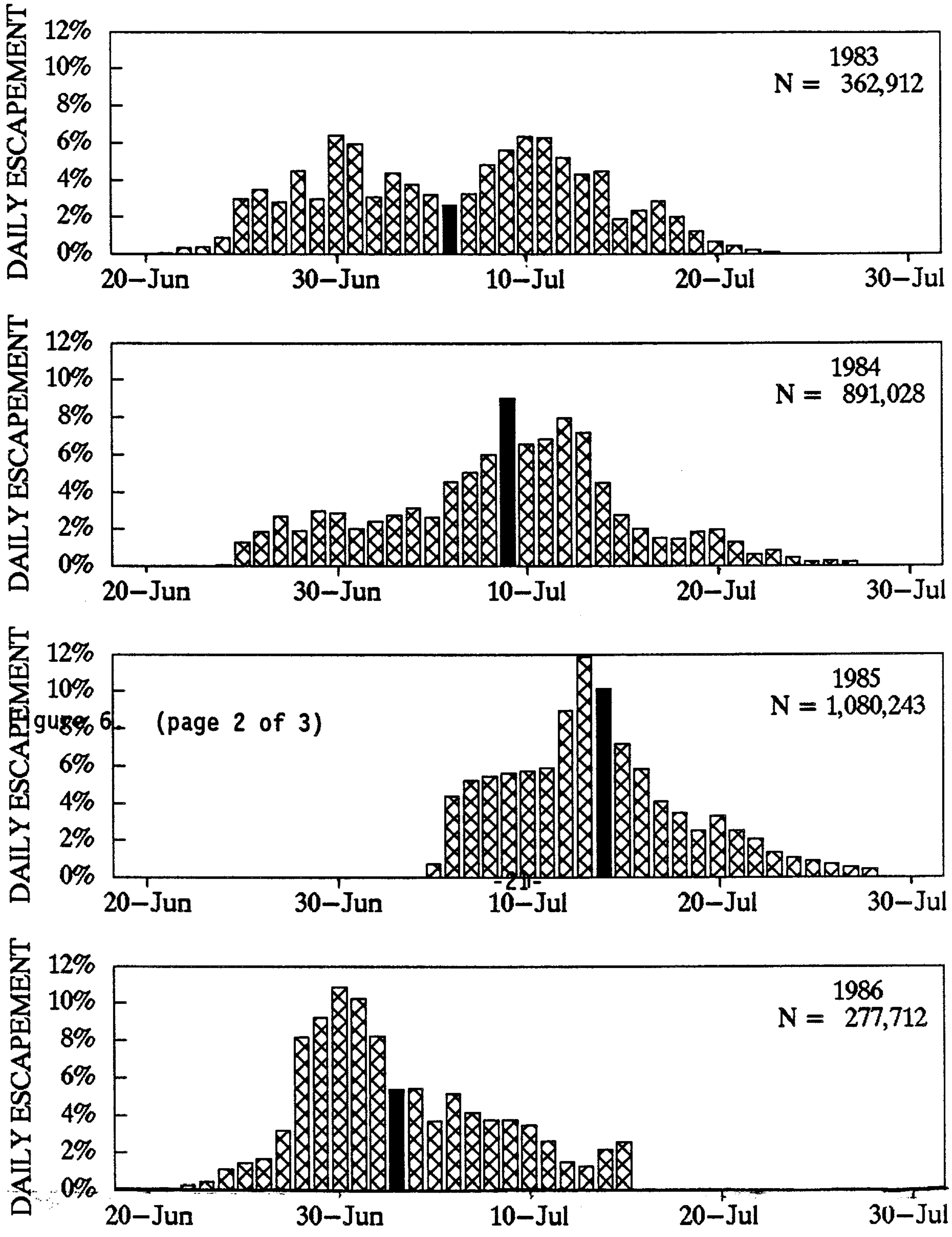

Figure 6. (page 2 of 3)

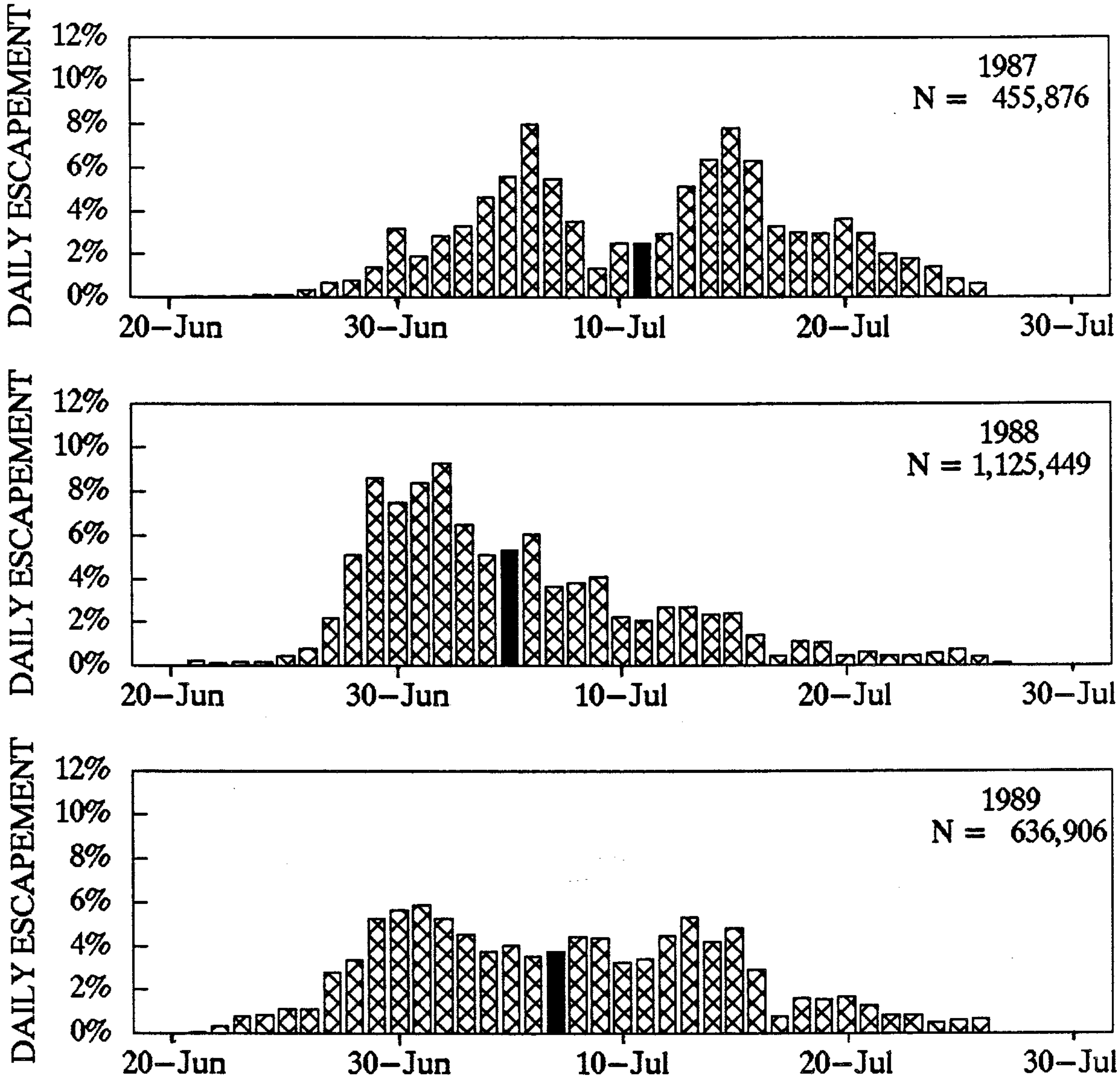

Figure 6. (page 3 of 3)

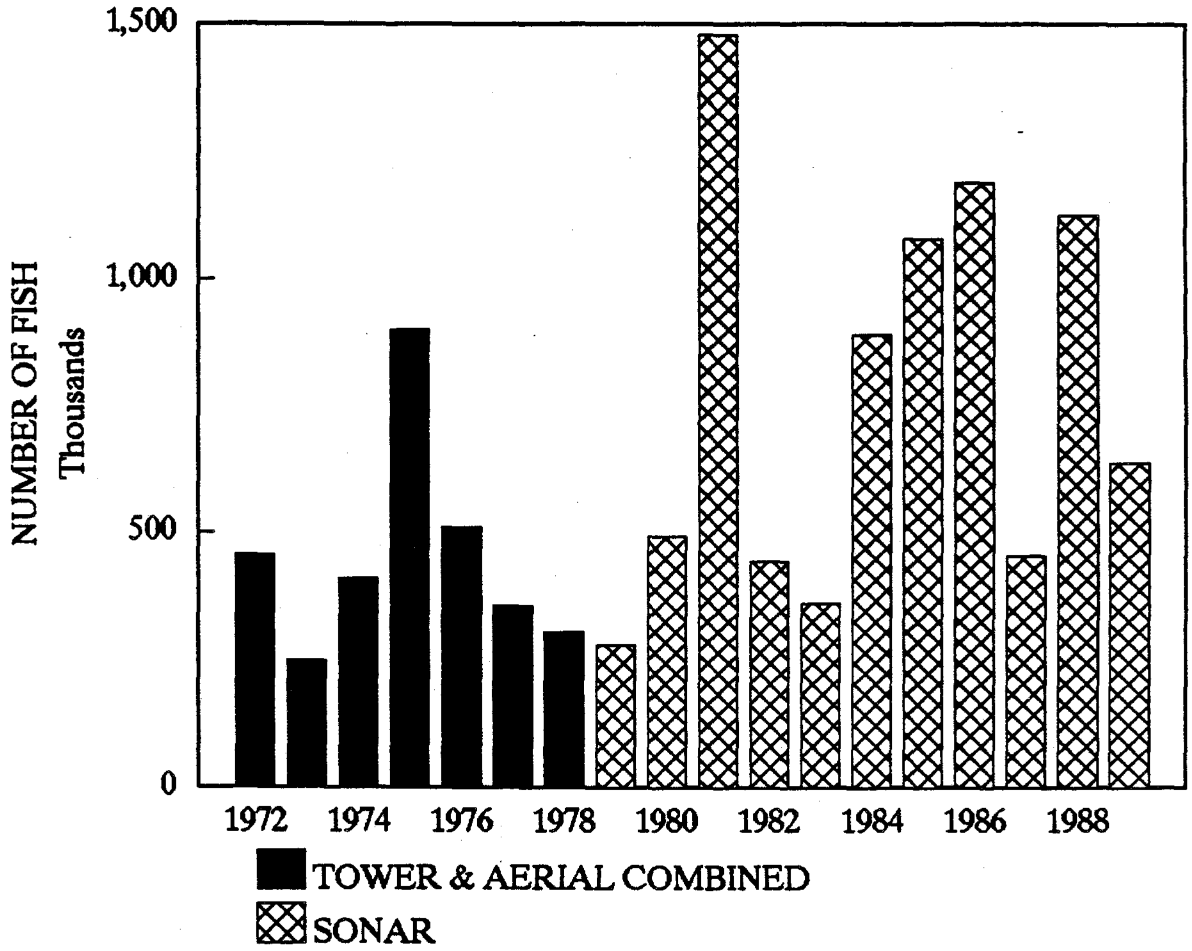

Figure 7. Anvik River summer chum salmon escapement estimated by combined tower and aerial survey count, 1972-1978, and by side-scanning sonar, 1979-1989.

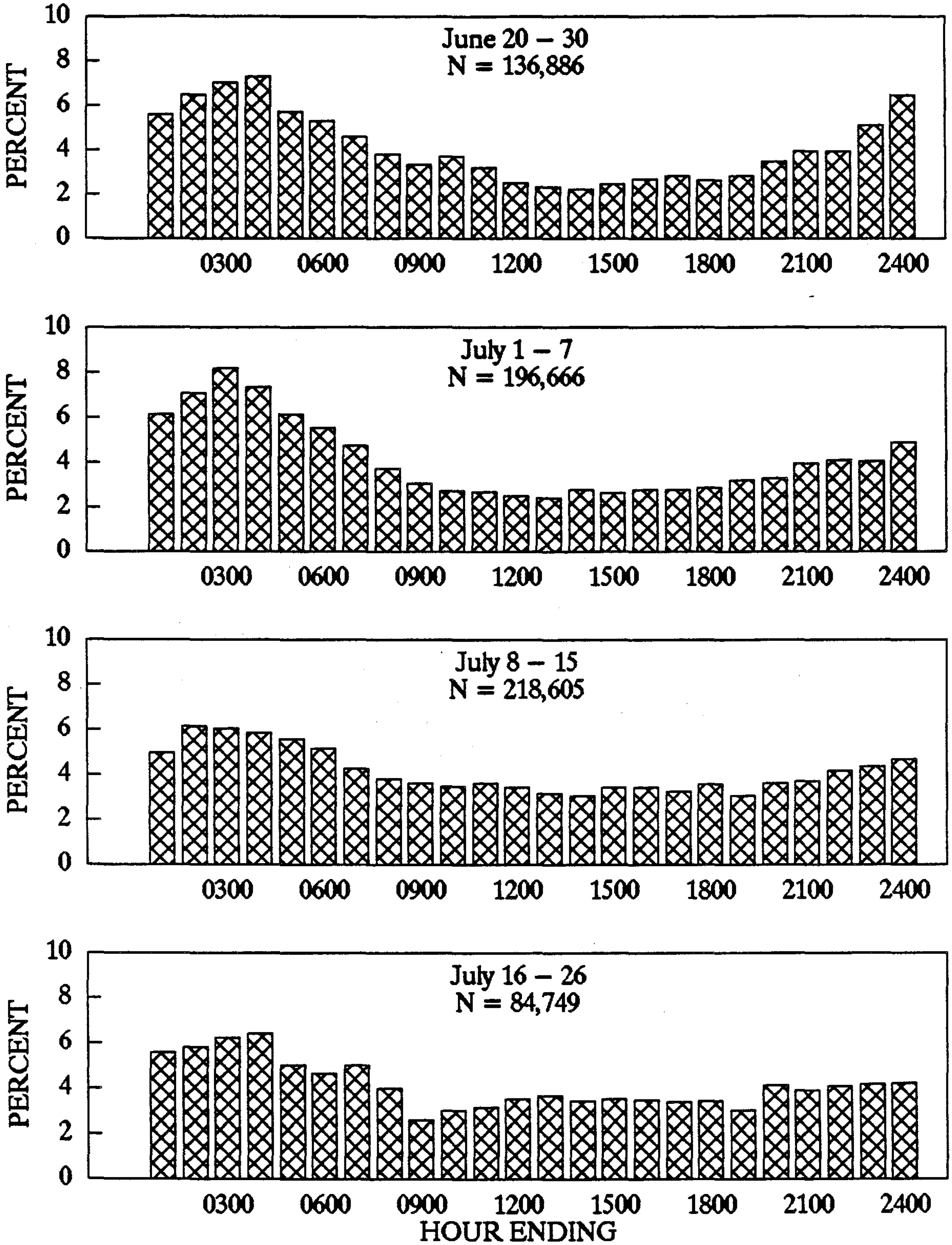

Figure 8. Anvik River corrected sonar counts of summer chum salmon passage by hour of the day, 1989.

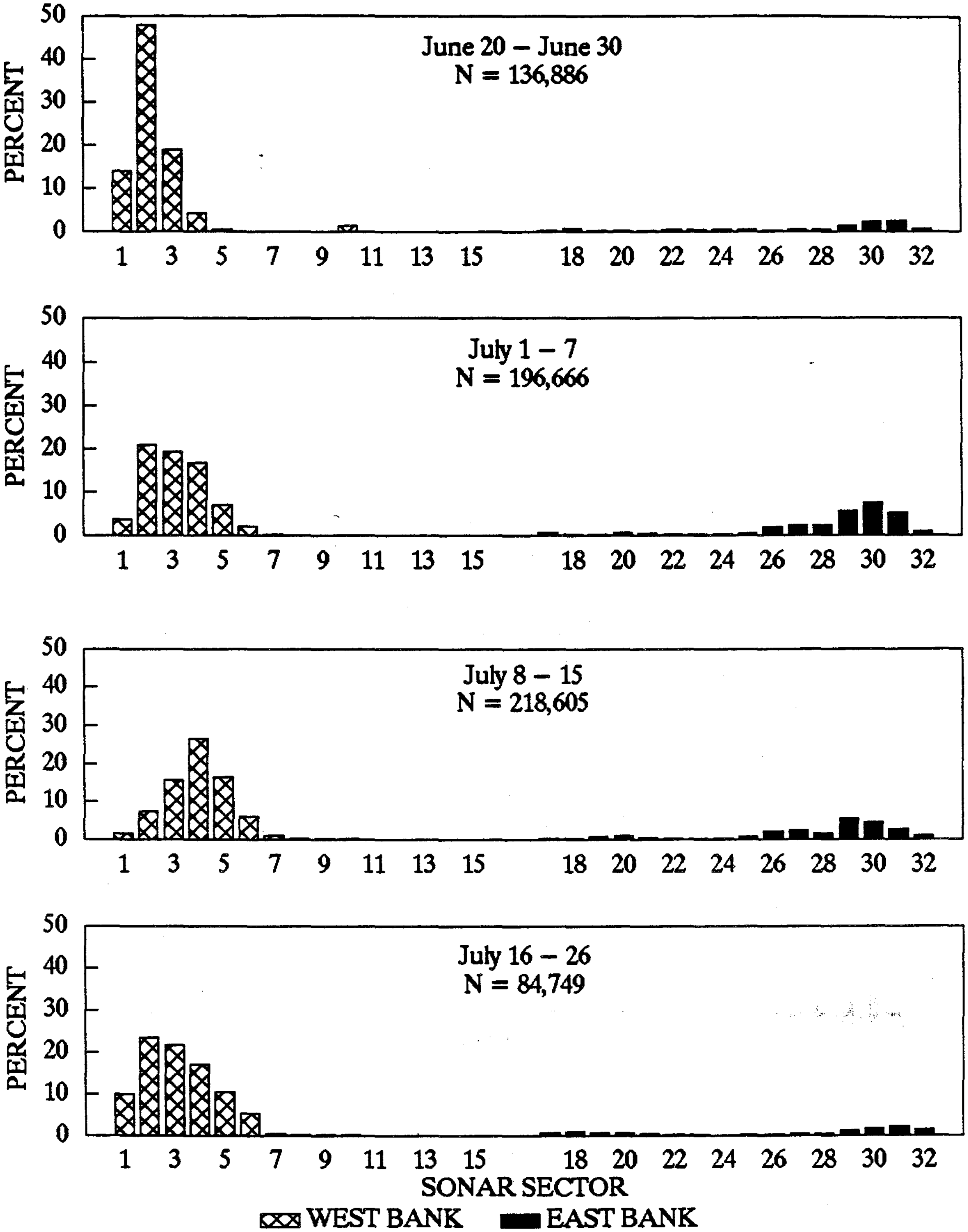

Figure 9. Anvik River corrected sonar counts of summer chum salmon passage by sonar sector, 1989.

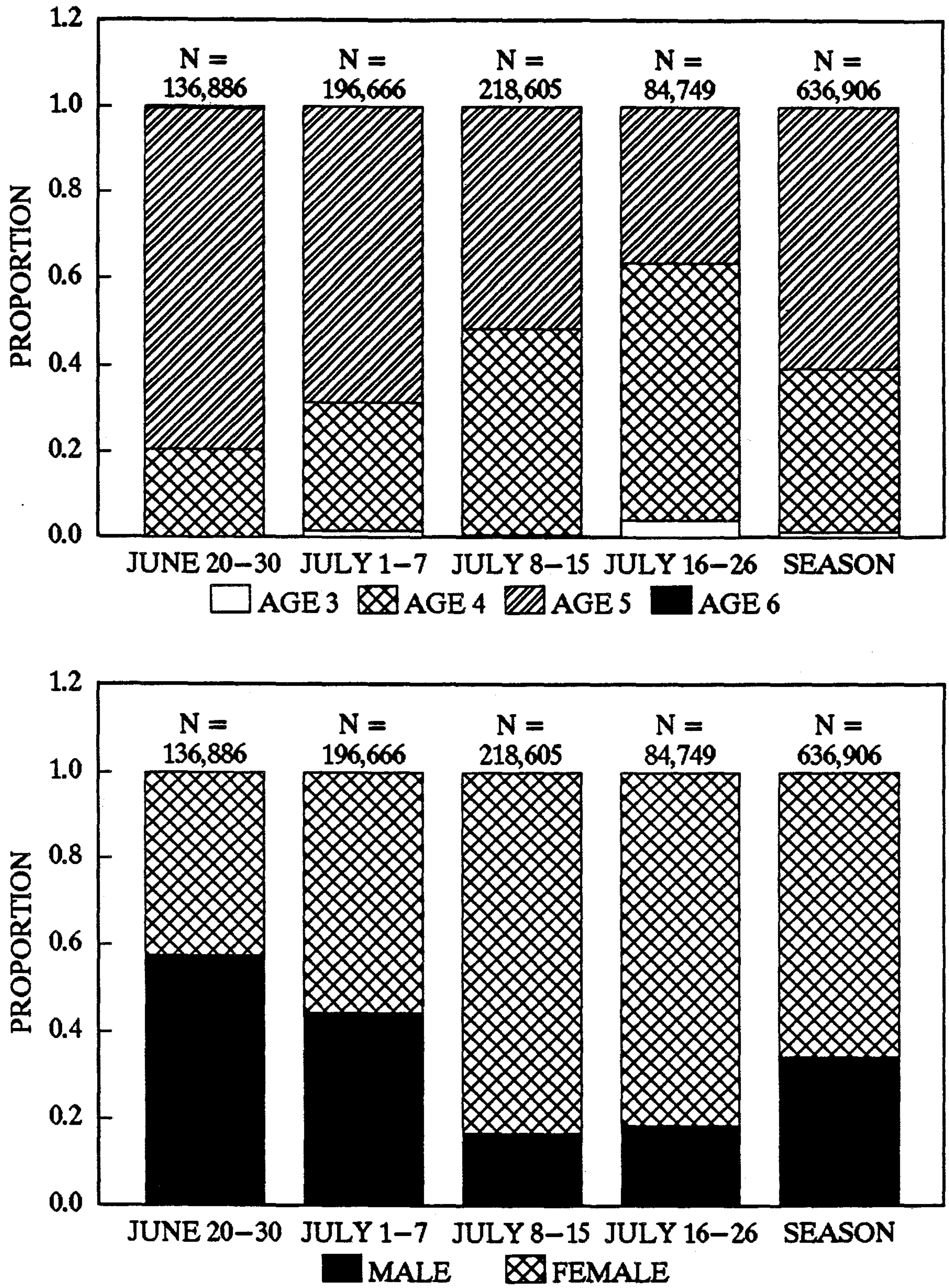

Figure 10. Age and sex composition of sampled Anvik River summer chum salmon by sampling strata, 1989.

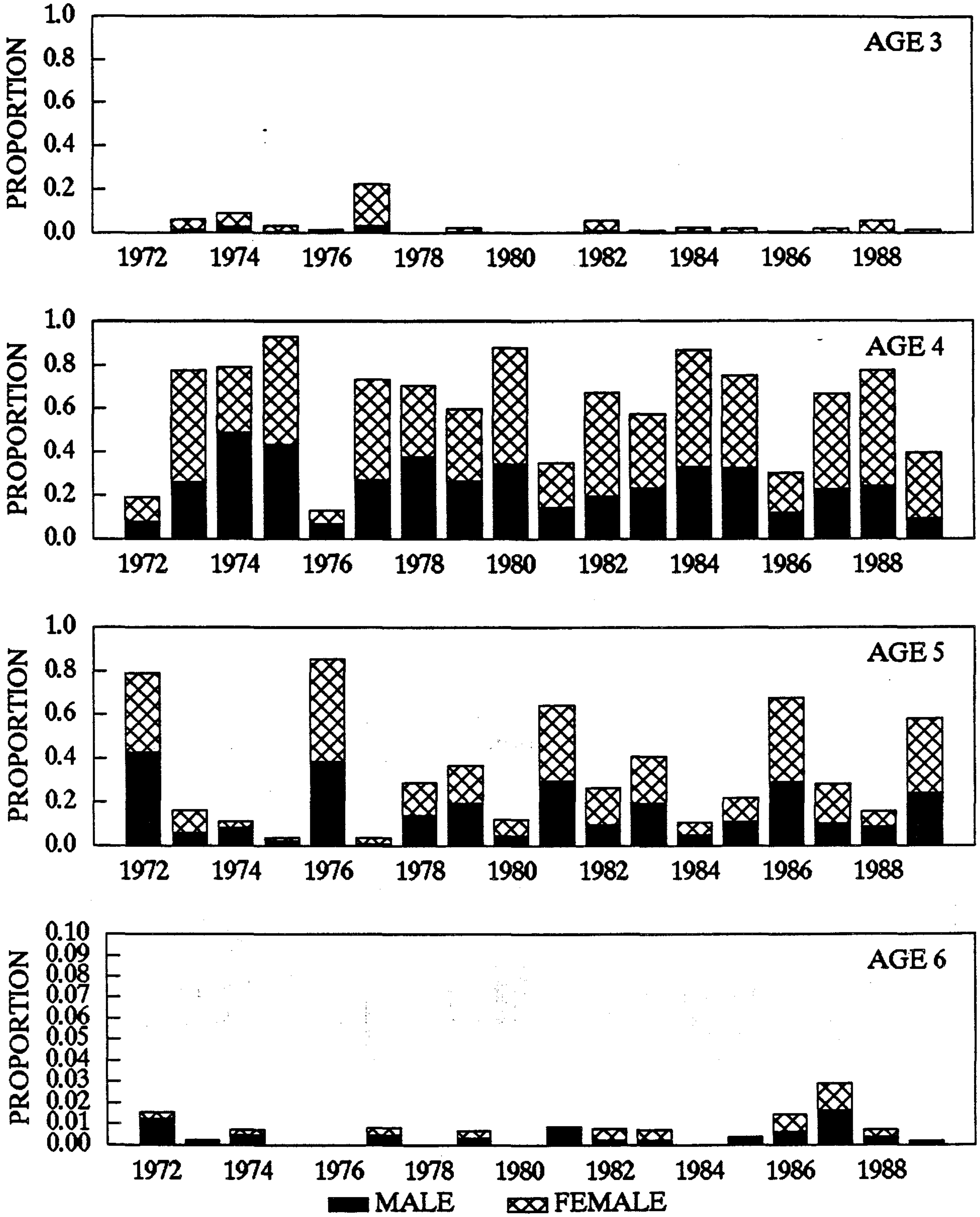

Figure 11. Age and sex composition of sampled Anvik River summer chum salmon, 1972-1989. (Note different Y-axis scale for age-6 salmon.)

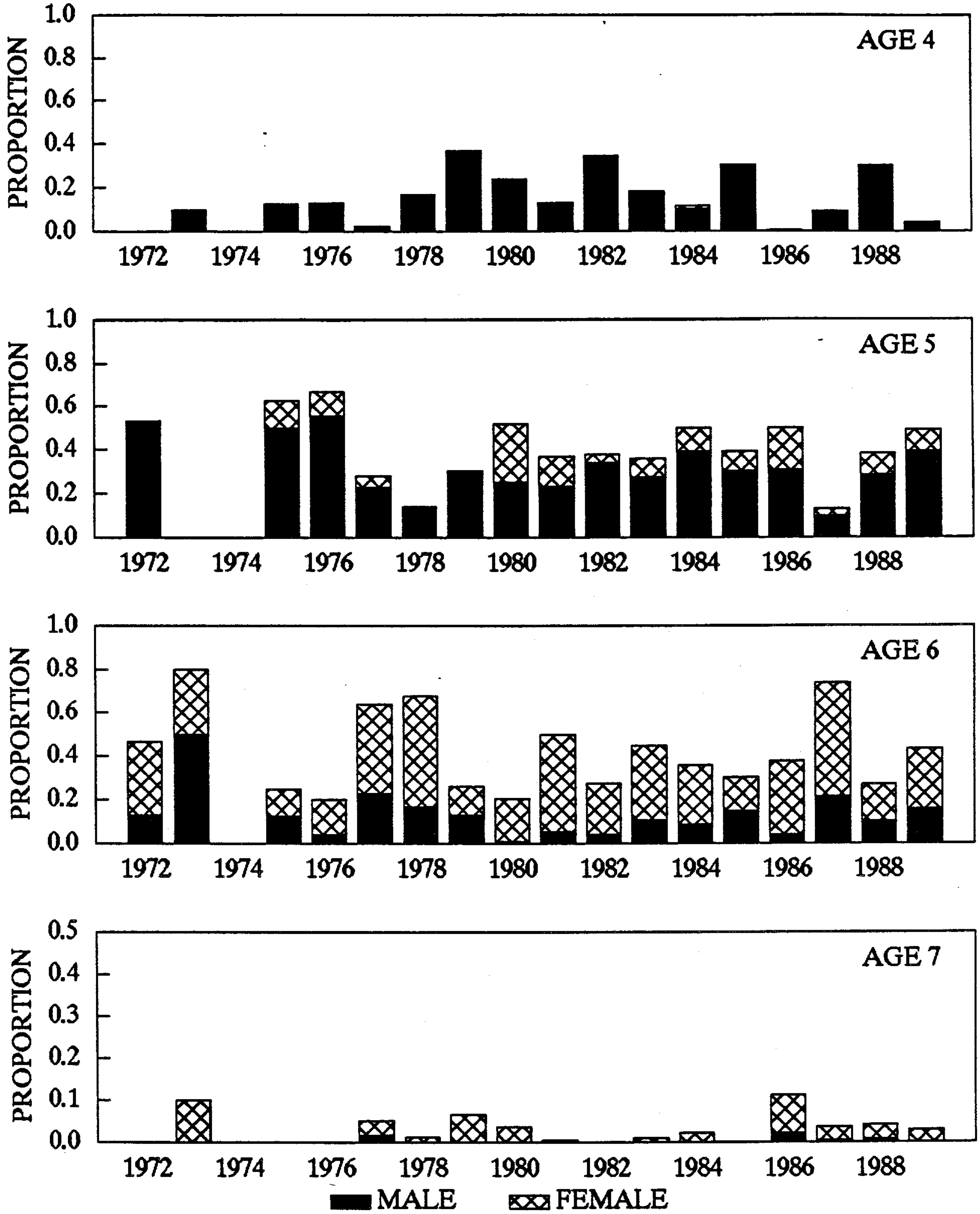

Figure 12. Age and sex composition of sampled Anvik River chinook salmon, 1972-1989. (Note different Y-axis scale for age-7 salmon.)

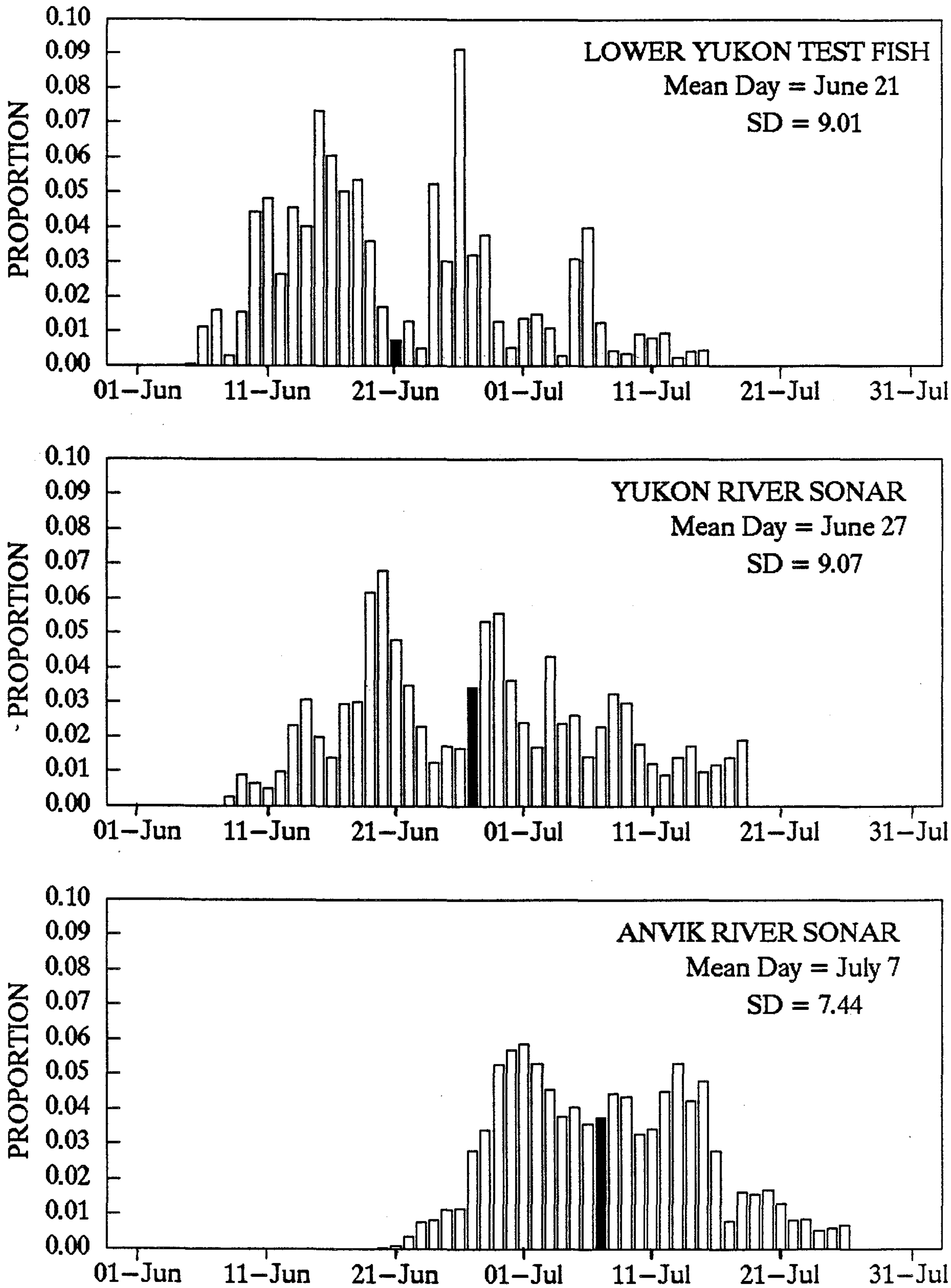

Figure 13. Run timing of Yukon River summer chum salmon in 1989 as indicated by test fish catches or sonar counts at three sites. Mean date of run passage is indicated by the shaded bar.

APPENDICES

Appendix A.1. West bank Anvik River corrected sonar counts by hour of the day, June 20 - July 26, 1989.

Hour Ending	20-Jun	21-Jun	22-Jun	23-Jun	24-Jun	25-Jun	26-Jun	27-Jun	28-Jun	29-Jun	30-Jun	01-Jul	02-Jul	03-Jul	04-Jul	05-Jul	06-Jul	07-Jul	08-Jul
0100	0	0	104	378	435	366	580	695	1,181	1,831	1,697	1,653	1,760	1,712	1,222	772	803	1,022	947
0200	0	0	106	416	364	554	519	1,165	1,183	2,169	1,873	1,641	2,274	2,120	1,151	1,137	902	1,452	1,355
0300	0	0	165	492	317	598	424	1,168	1,515	2,255	2,354	2,206	2,361	2,691	1,846	1,316	957	1,666	1,442
0400	0	0	107	489	334	540	442	1,253	1,861	2,251	2,331	2,777	2,514	1,888	1,589	1,018	745	1,381	1,129
0500	0	0	94	300	228	397	437	650	1,197	2,352	1,655	2,143	1,902	1,581	1,610	1,018	709	981	1,349
0600	0	0	83	253	175	363	514	621	820	2,127	1,404	1,681	1,667	1,593	1,227	972	417	890	1,069
0700	0	0	104	158	175	351	314	239	762	1,989	1,439	1,591	1,451	1,169	1,009	658	447	857	959
0800	0	0	116	156	143	227	148	385	657	1,587	1,080	982	997	895	867	522	466	571	826
0900	0	0	71	100	75	228	167	443	592	1,341	996	589	767	617	476	536	529	592	746
1000	0	0	48	94	105	238	296	497	803	1,259	1,138	438	551	411	330	484	816	630	713
1100	0	24	81	118	91	192	246	153	765	1,165	1,066	487	416	478	348	369	889	480	596
1200	0	0	0	31	49	281	147	200	594	830	762	312	444	349	215	409	872	706	574
1300	0	0	0	82	59	274	109	148	670	759	406	414	378	396	215	383	1,002	443	581
1400	0	0	0	50	134	245	47	247	499	693	578	419	566	407	439	592	799	468	499
1500	0	0	1	30	192	175	64	668	521	760	405	447	439	324	297	672	491	543	564
1600	0	0	0	36	170	127	58	475	611	1,050	611	320	559	461	352	541	529	740	600
1700	0	0	0	41	214	258	70	878	893	619	426	521	546	289	410	553	480	483	659
1800	0	0	0	110	260	150	105	819	477	641	527	515	512	292	243	498	449	466	590
1900	0	25	0	103	135	119	163	625	748	720	622	733	340	460	429	344	638	545	767
2000	0	29	0	186	72	134	574	825	721	638	614	776	652	449	306	556	419	556	745
2100	0	26	0	233	227	119	375	1,150	437	1,337	564	979	502	523	471	801	880	631	722
2200	0	45	0	291	315	257	392	991	535	895	486	1,015	1,050	386	614	773	706	613	773
2300	0	133	269	206	182	296	244	1,145	1,291	1,124	955	684	871	596	635	740	819	667	995
2400	0	69	342	343	187	447	564	1,305	1,716	1,407	1,190	1,269	1,302	952	679	641	895	738	1,170
Total	0	351	1,691	4,696	4,638	6,936	6,999	16,745	21,049	31,799	25,179	24,592	24,821	21,039	16,980	16,305	16,659	18,121	20,370

-Continued-

Appendix A.1. (page 2 of 2)

Hour Ending	09-Jul	10-Jul	11-Jul	12-Jul	13-Jul	14-Jul	15-Jul[a]	16-Jul[b]	17-Jul	18-Jul	19-Jul	20-Jul	21-Jul	22-Jul	23-Jul	24-Jul	25-Jul	26-Jul
0100	1,112	711	739	803	1,061	988	1,118	766	414	534	350	477	426	298	393	179	246	161
0200	1,518	1,042	1,061	993	1,591	1,339	1,300	756	211	494	449	638	477	211	389	257	194	300
0300	1,816	1,037	1,033	1,113	1,351	1,559	1,084	696	308	448	473	733	458	250	460	249	291	363
0400	1,745	1,097	769	1,046	1,521	1,535	1,148	786	425	521	487	772	454	256	394	239	343	283
0500	1,220	902	1,363	943	1,382	1,175	1,007	644	281	494	381	454	442	138	421	186	232	162
0600	1,079	834	708	955	1,455	944	1,139	673	207	540	298	463	433	225	325	161	227	90
0700	1,082	684	619	879	1,195	961	1,275	751	227	619	398	470	416	210	478	102	106	84
0800	828	448	458	934	996	743	963	585	207	446	343	408	439	70	199	107	78	121
0900	809	397	528	864	1,241	724	567	319	71	293	269	258	227	82	164	86	84	90
1000	801	371	642	873	1,109	862	505	276	46	358	389	320	275	139	238	50	66	112
1100	910	392	670	833	1,143	725	680	355	31	430	269	260	320	197	161	86	105	70
1200	787	398	744	834	886	641	769	403	36	542	291	316	296	183	194	106	88	136
1300	709	339	529	977	809	630	758	391	24	711	363	366	197	242	169	80	117	86
1400	642	348	559	742	746	725	842	438	35	577	365	296	184	225	140	74	95	75
1500	664	347	686	769	833	812	1,323	731	139	299	360	288	196	208	119	101	68	131
1600	783	442	528	839	700	601	1,405	759	112	364	296	291	183	207	55	75	99	117
1700	574	322	464	750	746	798	1,141	616	92	403	356	296	210	167	61	65	131	119
1800	847	414	636	1,037	764	675	1,006	559	111	410	326	291	239	187	98	89	109	144
1900	567	517	657	664	584	488	661	374	88	269	403	259	224	231	74	99	82	121
2000	480	626	639	748	739	601	1,492	960	427	336	432	332	152	204	68	82	85	146
2100	546	723	625	856	753	485	1,351	876	401	322	398	254	227	139	78	89	89	124
2200	386	739	564	888	961	815	1,474	921	368	409	348	320	202	160	62	79	45	162
2300	464	624	778	826	988	827	1,474	919	365	366	351	384	180	184	86	93	82	105
2400	567	869	880	902	1,087	902	1,532	951	369	144	462	346	176	251	76	146	64	144
Total	20,936	14,623	16,879	21,068	24,641	20,555	26,014	15,505	4,995	10,329	8,857	9,292	7,033	4,664	4,902	2,880	3,126	3,446

[a]Data unavailable for the period 1900 - 2400. Counts estimated and distributed based on available July 15 data and the mean proportion and distribution pattern of counts for that timeperiod on July 14 and 17.
[b]Data for the 24-h period unavailable. Hourly counts were interpolated.

Appendix A.2. East bank Anvik River corrected sonar counts by hour of the day, June 20 - July 26, 1989.

Hour Ending	20-Jun	21-Jun	22-Jun	23-Jun	24-Jun	25-Jun	26-Jun	27-Jun	28-Jun	29-Jun	30-Jun	01-Jul	02-Jul	03-Jul	04-Jul	05-Jul	06-Jul	07-Jul	08-Jul
0100	33	0	0	3	0	8	4	13	31	33	287	534	553	537	350	547	400	208	390
0200	84	0	6	10	33	2	3	17	23	26	326	880	566	299	250	590	393	306	320
0300	1	0	166	14	11	0	1	3	15	4	151	868	419	295	474	408	279	324	263
0400	4	0	73	1	8	0	7	2	6	15	286	522	250	325	256	521	411	303	212
0500	4	0	24	11	6	1	15	23	40	12	397	492	280	301	276	321	345	108	261
0600	0	0	92	14	28	24	17	11	41	32	665	564	329	393	291	488	258	158	299
0700	33	7	157	31	22	13	22	34	19	43	426	643	286	267	244	309	234	157	210
0800	0	0	0	20	29	9	10	48	46	56	503	422	293	249	291	349	206	200	263
0900	0	0	0	22	37	21	9	81	12	68	309	548	297	235	236	303	187	167	279
1000	2	0	0	7	35	32	15	45	31	87	360	429	283	244	265	189	139	217	320
1100	0	0	13	15	25	42	48	46	26	86	231	394	549	204	240	211	116	169	331
1200	0	0	2	12	182	18	7	48	36	89	159	293	452	212	255	195	112	160	282
1300	0	1	2	4	106	21	15	80	19	193	254	343	343	181	204	241	108	111	228
1400	0	0	0	14	44	28	4	94	11	117	280	468	251	222	123	269	309	158	241
1500	0	0	0	7	7	19	32	112	8	117	284	453	351	251	232	428	149	147	211
1600	0	3	4	6	3	18	12	72	15	117	315	486	380	235	246	349	174	177	264
1700	0	13	1	0	7	9	15	33	36	117	288	349	370	288	252	630	208	155	307
1800	0	2	6	1	10	0	9	66	37	117	305	574	378	382	344	421	245	361	482
1900	0	20	3	6	7	12	21	48	22	117	381	550	485	327	335	507	293	307	547
2000	1	35	0	8	8	0	13	57	31	117	721	503	319	512	401	519	253	314	535
2100	0	15	0	8	8	7	9	33	19	80	791	536	349	433	482	406	288	536	384
2200	0	26	2	0	0	20	23	28	25	30	1,093	607	330	468	403	407	316	367	489
2300	0	21	2	7	4	17	15	28	17	21	1,074	799	376	358	269	458	320	348	446
2400	0	3	0	2	0	11	28	25	17	40	1,163	611	433	776	359	426	266	328	298
Total	162	146	553	223	620	332	354	1,047	583	1,734	11,049	12,868	8,922	7,994	7,078	9,492	6,009	5,786	7,862

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Hour Ending	09-Jul	10-Jul	11-Jul	12-Jul	13-Jul	14-Jul	15-Jul	16-Jul[a]	17-Jul[b]	18-Jul	19-Jul	20-Jul	21-Jul	22-Jul	23-Jul	24-Jul	25-Jul	26-Jul
0100	555	290	327	630	679	190	415	208	1	0	27	90	40	35	22	30	29	30
0200	686	420	217	312	583	475	286	143	0	0	22	87	58	80	34	34	61	44
0300	328	266	257	607	457	365	286	143	0	0	18	65	149	19	57	19	93	19
0400	394	284	173	358	724	394	286	143	0	0	13	29	143	21	30	31	34	51
0500	274	606	283	317	569	227	316	158	0	1	27	76	92	21	17	4	10	23
0600	547	650	179	315	618	337	172	86	0	0	12	25	70	43	14	19	17	23
0700	150	172	163	207	243	371	259	130	1	2	22	63	37	70	41	17	10	33
0800	239	172	167	301	237	630	151	76	0	1	20	85	45	43	28	40	30	47
0900	244	129	141	222	330	592	164	82	0	0	18	59	43	11	6	23	1	26
1000	251	146	152	222	361	145	224	112	0	0	17	39	59	10	16	12	20	31
1100	259	198	146	263	358	163	254	127	0	1	24	64	52	33	16	17	22	49
1200	238	190	173	230	382	180	244	123	2	35	30	44	80	7	25	8	19	30
1300	163	77	214	255	352	155	146	73	0	2	77	91	42	15	10	33	9	43
1400	166	155	183	258	349	80	158	79	1	63	57	69	43	13	23	15	14	46
1500	144	218	170	236	236	81	262	131	0	1	57	63	30	9	22	18	7	20
1600	207	212	199	278	229	65	212	106	0	8	91	86	37	13	17	7	29	33
1700	193	136	197	315	272	77	237	120	2	2	73	42	47	12	14	4	9	29
1800	214	188	204	221	282	120	127	63	0	1	70	46	40	28	26	23	22	25
1900	213	239	193	216	219	134	83	42	0	2	71	81	17	26	10	31	18	30
2000	165	187	235	263	281	142	70	35	0	1	51	88	26	21	18	9	32	32
2100	215	306	253	360	333	145	64	32	0	4	62	71	30	16	31	13	30	49
2200	352	255	243	371	392	411	44	22	1	4	105	92	10	37	34	19	35	45
2300	337	303	213	540	338	411	72	36	0	1	102	59	47	30	23	30	53	50
2400	293	368	243	372	356	411	56	28	0	2	112	66	29	23	54	30	97	40
Total	6,827	6,167	4,925	7,669	9,180	6,301	4,588	2,298	8	131	1,178	1,580	1,266	636	588	486	701	848

[a]Data unavailable for the 24-h period. Hourly counts were interpolated.
[b]Data unavialable for the period 0000 - 1300. Counts for that period were estimated based on available July 17 data and the mean proportion and distribution pattern of counts for that time period on July 15 and 18.

Appendix A.3. West bank Anvik River sonar counts by sector, June 21 - July 26, 1989.

Sector	20-Jun	21-Jun	22-Jun	23-Jun	24-Jun	25-Jun	26-Jun	27-Jun	28-Jun	29-Jun	30-Jun	01-Jul	02-Jul	03-Jul	04-Jul	05-Jul	06-Jul	07-Jul	08-Jul
1	0	69	163	417	462	593	84	4,058	6,265	5,808	1,351	4,494	2,330	141	120	86	19	125	71
2	0	212	714	2,293	2,803	3,625	1,573	6,079	10,911	21,735	15,667	15,758	12,414	6,213	4,067	1,549	380	698	396
3	0	70	762	1,722	1,133	2,311	3,754	3,334	2,013	3,380	7,458	3,812	5,523	9,641	7,819	5,727	2,347	3,362	3,001
4	0	0	52	253	218	365	1,399	2,660	279	77	603	410	3,858	4,032	4,210	5,299	7,628	7,376	9,175
5	0	0	0	9	13	13	121	475	16	4	43	23	471	692	520	2,553	4,592	4,735	5,464
6	0	0	0	2	4	2	27	65	7	3	6	10	73	133	121	929	1,466	1,495	2,009
7	0	0	0	0	1	3	9	24	4	1	4	10	41	81	59	55	80	172	154
8	0	0	0	0	0	0	1	2	1	2	1	0	8	8	9	35	56	60	29
9	0	0	0	0	2	1	5	12	5	147	5	6	24	37	19	29	27	23	24
10	0	0	0	0	1	3	10	9	1,296	510	9	11	20	22	12	28	32	30	25
11	0	0	0	0	1	1	4	6	96	4	1	19	21	20	3	7	22	23	13
12	0	0	0	0	0	1	2	6	2	4	4	3	5	7	6	0	4	6	2
13	0	0	0	0	0	3	4	5	1	2	1	2	3	2	2	1	2	2	3
14	0	0	0	0	0	4	2	4	4	1	1	1	0	4	10	4	1	4	3
15	0	0	0	0	0	4	0	4	4	113	25	16	16	3	1	1	2	7	0
16	0	0	0	0	0	7	4	2	145	8	0	17	14	3	2	2	1	3	1
Total	0	351	1,691	4,696	4,638	6,936	6,999	16,745	21,049	31,799	25,179	24,592	24,821	21,039	16,980	16,305	16,659	18,121	20,370

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Sector	09-Jul	10-Jul	11-Jul	12-Jul	13-Jul	14-Jul	15-Jul[a]	16-Jul[b]	17-Jul	18-Jul	19-Jul	20-Jul	21-Jul	22-Jul	23-Jul	24-Jul	25-Jul	26-Jul
1	78	20	57	30	60	82	3,239	2,556	1,872	461	322	817	64	523	749	374	444	202
2	343	585	599	416	1,019	2,234	10,609	6,018	1,427	1,284	1,128	1,814	386	1,524	2,368	1,289	1,654	996
3	3,098	2,696	2,152	2,497	4,403	7,501	8,891	4,762	634	2,352	2,665	2,398	1,438	1,056	1,157	610	621	644
4	9,612	5,311	6,266	8,170	9,569	7,204	2,624	1,620	616	2,914	2,463	2,190	2,275	586	329	302	274	757
5	5,349	3,747	4,987	6,890	6,554	2,456	433	355	277	2,109	1,535	1,341	1,851	528	163	180	68	486
6	2,108	1,734	1,927	2,309	2,189	736	171	146	120	1,061	624	660	950	375	81	97	45	259
7	227	271	320	488	462	179	16	12	8	66	61	38	46	30	31	22	17	46
8	19	54	75	63	72	42	5	4	4	18	21	16	7	11	9	4	1	11
9	29	72	164	59	84	38	15	18	20	34	26	12	8	8	4	1	0	13
10	31	75	155	58	84	26	4	5	6	29	8	5	8	17	7	1	0	10
11	24	25	136	36	48	30	2	2	3	1	0	0	0	2	0	0	1	4
12	5	6	18	10	17	12	1	2	2	0	4	1	0	1	1	0	0	6
13	2	7	8	20	16	4	2	2	3	0	0	0	0	1	0	0	1	8
14	1	8	4	7	25	4	1	1	1	0	0	0	0	1	1	0	0	1
15	5	6	6	7	24	4	0	0	0	0	0	0	0	1	1	0	0	1
16	5	6	5	8	15	3	1	2	2	0	0	0	0	0	1	0	0	2
Total	20,936	14,623	16,879	21,068	24,641	20,555	26,014	15,505	4,995	10,329	8,857	9,292	7,033	4,664	4,902	2,880	3,126	3,446

[a]Data for the period 1900 - 2400 unavailable. Counts estimated based on the available July 15 data and the and the mean proportion of counts for that time period on July 14 and 17. Estimated counts distributed by sector based on distribution pattern for counts on July 14 and 17.
[b]Count data unavailable for the 24-hour period. Sector counts were interpolated.

Appendix A.4. East bank Anvik River sonar counts by sector, June 20 - July 26, 1989.

Sector	20-Jun	21-Jun	22-Jun	23-Jun	24-Jun	25-Jun	26-Jun	27-Jun	28-Jun	29-Jun	30-Jun	01-Jul	02-Jul	03-Jul	04-Jul	05-Jul	06-Jul	07-Jul	08-Jul
17	0	0	7	15	20	42	30	49	48	97	43	128	457	418	74	146	71	45	44
18	0	0	3	112	486	109	15	52	108	91	37	46	61	55	63	42	35	37	38
19	0	0	0	8	18	23	47	61	34	36	21	44	28	62	63	98	60	139	265
20	0	0	3	13	24	22	56	111	68	115	43	109	129	355	118	116	131	458	574
21	0	0	3	11	12	20	23	88	51	84	190	156	259	464	87	65	50	90	58
22	0	0	2	23	24	29	41	180	86	181	32	89	100	122	66	89	53	59	31
23	0	0	4	29	18	47	70	221	118	282	21	72	100	84	85	68	52	51	76
24	0	0	18	12	15	38	69	276	68	132	12	24	42	30	39	26	74	89	89
25	0	51	511	0	0	0	1	9	0	110	72	128	178	114	166	179	145	121	147
26	43	86	0	0	0	0	0	0	0	68	257	474	630	527	516	746	617	333	518
27	114	7	0	0	0	0	0	0	0	90	443	748	816	787	760	777	582	310	294
28	5	0	0	0	0	0	0	0	0	86	606	867	761	693	681	552	603	314	469
29	0	0	0	0	0	0	0	0	0	125	1,686	2,491	1,455	1,324	1,432	1,884	1,349	952	2,134
30	0	0	0	0	0	0	0	0	0	136	3,113	4,041	1,824	1,476	1,641	2,928	1,413	1,519	1,866
31	0	1	0	0	1	1	1	0	0	58	3,626	2,956	1,672	1,197	1,099	1,519	687	1,094	1,107
32	0	1	2	0	2	1	1	0	2	43	847	495	410	286	188	257	87	175	152
Total	162	146	553	223	620	332	354	1,047	583	1,734	11,049	12,868	8,922	7,994	7,078	9,492	6,009	5,786	7,862

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Sector	09-Jul	10-Jul	11-Jul	12-Jul	13-Jul	14-Jul	15-Jul	16-Jul[a]	17-Jul[b]	18-Jul	19-Jul	20-Jul	21-Jul	22-Jul	23-Jul	24-Jul	25-Jul	26-Jul
17	61	111	120	77	85	61	36	19	1	9	106	75	92	109	123	2	24	10
18	70	231	112	50	53	50	11	6	0	4	312	67	92	82	88	43	91	36
19	419	433	152	57	152	58	16	8	0	21	262	32	42	39	40	45	92	36
20	548	221	102	183	787	82	36	18	0	20	171	35	31	45	36	38	86	39
21	63	134	55	295	296	61	26	13	0	18	80	39	24	22	18	13	28	16
22	32	114	117	86	50	48	33	17	0	12	23	21	17	14	12	6	16	10
23	218	152	162	96	61	59	21	11	1	5	8	17	15	6	3	4	8	10
24	260	167	90	135	60	57	18	9	0	1	10	3	2	4	2	2	4	14
25	285	164	131	304	275	191	75	38	0	0	3	12	9	8	11	3	3	2
26	662	507	335	674	502	1,084	249	125	0	0	10	12	15	15	1	9	8	15
27	359	796	432	821	732	1,439	485	242	0	0	27	22	15	7	4	14	11	28
28	441	658	518	543	540	260	96	48	0	6	35	100	80	23	13	20	20	53
29	1,913	729	960	2,121	2,725	1,123	378	190	2	11	39	300	222	75	50	46	47	87
30	889	1,277	1,168	1,507	1,968	806	560	280	2	12	29	367	267	94	80	45	61	105
31	506	377	354	563	736	696	1,314	657	1	10	32	369	260	78	84	82	93	220
32	101	96	117	157	158	226	1,234	617	1	2	31	109	83	15	23	114	109	167
Total	6,827	6,167	4,925	7,669	9,180	6,301	4,588	2,298	8	131	1,178	1,580	1,266	636	588	486	701	848

[a]Data unavailable for the 24-h period. Sector counts were interpolated.

[b]Data unavailable for the period 0000 - 1300. Counts for that period were based on available July 17 data and the mean proportion of counts for that time period on July 15 and 18. Estimated counts were distributed by sector based on sector distribution pattern of counts on July 15 and 18.

Appendix A.5. Anvik River salmon beach seine catch by species, sex, and date, 1989.[a]

Date	Number Of Sets	Chum			Chinook			Pink		
		Male	Female	Total	Male	Female	Total	Male	Female	Total
27-Jun	3	24	17	41	0	0	0	0	0	0
28-Jun	3	26	17	43	0	0	0	0	0	0
29-Jun	0									
30-Jun	1	48	39	87	0	0	0	0	0	0
01-Jul	0									
02-Jul	1	50	52	102	0	0	0	0	0	0
03-Jul	0									
04-Jul	0									
05-Jul	2	10	11	21	0	0	0	0	0	0
06-Jul	1	23	55	78	0	0	0	0	0	0
07-Jul	0									
08-Jul	0									
09-Jul	0									
10-Jul	1	20	80	100	0	0	0	0	0	0
11-Jul	1	6	46	52	0	0	0	0	0	0
12-Jul	0									
13-Jul	0									
14-Jul	0									
15-Jul	0									
16-Jul	0									
17-Jul	0									
18-Jul	1	3	37	40	0	0	0	0	0	0
19-Jul	1	3	20	23	0	0	0	0	0	0
20-Jul	0									
21-Jul	2	9	29	38	0	0	0	0	0	0
22-Jul	3	13	42	55	0	0	0	0	0	0
Total	20	235	445	680	0	0	0	0	0	0

[a] Beach seining on June 27 was conducted at a site on the east bank approximately 500 meters upstream of the ADF&G field camp. All other beach seining activities were conducted approximately 200 meters upstream of ADF&G field camp site on the west bank of the river.

Appendix A.6. Age and sex composition of Anvik River summer chum salmon escapement samples, 1972 - 1989.[a]

				Number of Fish											
	Sample Number			Age 0.2			Age 0.3			Age 0.4			Age 0.5		
Year	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
1972	167	153	320	0	0	0	25	37	62	138	115	253	4	1	5
1973	265	518	783	11	37	48	204	401	605	49	79	128	1	1	2
1974	245	157	402	12	24	36	197	120	317	34	12	46	2	1	3
1975	270	314	584	4	17	21	253	288	541	13	9	22	0	0	0
1976	281	320	601	5	4	9	43	35	78	233	281	514	0	0	0
1977	191	398	589	20	111	131	161	270	431	7	15	22	3	2	5
1978	289	263	552	0	1	1	210	180	390	79	82	161	0	0	0
1979	273	306	579	2	12	14	154	193	347	115	99	214	2	2	4
1980	167	258	425	0	1	1	147	226	373	20	31	51	0	0	0
1981	151	182	333	0	0	0	49	67	116	99	115	214	3	0	3
1982	117	265	382	4	17	21	75	181	256	37	65	102	1	2	3
1983	183	238	421	0	4	4	99	142	241	83	90	173	1	2	3
1984	138	215	353	2	6	8	117	189	306	19	20	39	0	0	0
1985	233	294	527	0	11	11	172	225	397	59	58	117	2	0	2
1986	205	281	486	0	2	2	59	89	148	143	186	329	3	4	7
1987	190	355	545	0	10	10	125	238	363	56	100	156	9	7	16
1988	180	351	531	1	30	31	129	282	411	48	37	85	2	2	4
1989	199	389	588	0	9	9	55	179	234	143	201	344	1	0	1

				Percent of Total Sample[b]											
	Sample Number			Age 0.2			Age 0.3			Age 0.4			Age 0.5		
Year	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
1972	52.2	47.8	100.0	0.0	0.0	0.0	7.8	11.6	19.4	43.1	35.9	79.1	1.3	0.3	1.6
1973	33.8	66.2	100.0	1.4	4.7	6.1	26.1	51.2	77.3	6.3	10.1	16.3	0.1	0.1	0.3
1974	60.9	39.1	100.0	3.0	6.0	9.0	49.0	29.9	78.9	8.5	3.0	11.4	0.5	0.2	0.7
1975	46.2	53.8	100.0	0.7	2.9	3.6	43.3	49.3	92.6	2.2	1.5	3.8	0.0	0.0	0.0
1976	46.8	53.2	100.0	0.8	0.7	1.5	7.2	5.8	13.0	38.8	46.8	85.5	0.0	0.0	0.0
1977	32.4	67.6	100.0	3.4	18.8	22.2	27.3	45.8	73.2	1.2	2.5	3.7	0.5	0.3	0.8
1978	52.4	47.6	100.0	0.0	0.2	0.2	38.0	32.6	70.7	14.3	14.9	29.2	0.0	0.0	0.0
1979	47.2	52.8	100.0	0.3	2.1	2.4	26.6	33.3	59.9	19.9	17.1	37.0	0.3	0.3	0.7
1980	39.3	60.7	100.0	0.0	0.2	0.2	34.6	53.2	87.8	4.7	7.3	12.0	0.0	0.0	0.0
1981	45.3	54.7	100.0	0.0	0.0	0.0	14.7	20.1	34.8	29.7	34.5	64.3	0.9	0.0	0.9
1982	30.6	69.4	100.0	1.0	4.5	5.5	19.6	47.4	67.0	9.7	17.0	26.7	0.3	0.5	0.8
1983	43.5	56.5	100.0	0.0	1.0	1.0	23.5	33.7	57.2	19.7	21.4	41.1	0.2	0.5	0.7
1984	39.1	60.9	100.0	0.6	1.7	2.3	33.1	53.5	86.7	5.4	5.7	11.0	0.0	0.0	0.0
1985	44.2	55.8	100.0	0.0	2.1	2.1	32.6	42.7	75.3	11.2	11.0	22.2	0.4	0.0	0.4
1986	42.2	57.8	100.0	0.0	0.4	0.4	12.1	18.3	30.5	29.4	38.3	67.7	0.6	0.8	1.4
1987	34.9	65.1	100.0	0.0	1.8	1.8	22.9	43.7	66.6	10.3	18.3	28.6	1.7	1.3	2.9
1988	33.9	66.1	100.0	0.2	5.6	5.8	24.3	53.1	77.4	9.0	7.0	16.0	0.4	0.4	0.8
1989	33.8	66.2	100.0	0.0	1.5	1.5	9.4	30.4	39.8	24.3	34.2	58.5	0.2	0.0	0.2
1989[c]	34.4	65.6	100.0	0.0	1.2	1.2	9.4	28.5	37.9	24.8	35.9	60.7	0.1	0.0	0.1

[a] Samples collected by carcass survey 1972-1981, by beach seine 1983-1989, and by both methods combined in 1982.
[b] Sample percentages not weighted by time period or escapement counts unless otherwise noted.
[c] Sample percentages weighted by time period and escapement counts.

Appendix A.7. Age and sex composition of Anvik River chinook salmon escapement samples, 1972-1989.[a]

				Numbers of Fish											
Year	Sample Male	Sample Female	Sample Total	Age 4 Male	Age 4 Female	Age 4 Total	Age 5 Male	Age 5 Female	Age 5 Total	Age 6 Male	Age 6 Female	Age 6 Total	Age 7 Male	Age 7 Female	Age 7 Total
1972	10	5	15	0	0	0	8	0	8	2	5	7	0	0	0
1973	6	4	10	1	0	1	0	0	0	5	3	8	0	1	1
1974	0	0	0												
1975	6	2	8	1	0	1	4	1	5	1	1	2	0	0	0
1976	33	12	45	6	0	6	25	5	30	2	7	9	0	0	0
1977	58	59	117	2	1	3	27	6	33	27	48	75	2	4	6
1978	36	41	77	13	0	13	10	1	11	13	39	52	0	1	1
1979	37	9	46	17	0	17	14	0	14	6	6	12	0	3	3
1980	41	42	83	19	1	20	21	22	43	1	16	17	0	3	3
1981	109	154	263	33	1	34	61	36	97	15	116	131	0	1	1
1982	100	38	138	47	1	48	47	5	52	6	32	38	0	0	0
1983	173	133	306	56[b]	0	56	84	26	110	33	104	137	0	3	3
1984	162	114	276	29	4	33	108	30	138	25	74	99	0	6	6
1985	25	8	33	10	0	10	10	3	13	5	5	10	0	0	0
1986	53	89	142	0	1	1	44	27	71	6	48	54	3	13	16
1987	92	130	222	21	0	21	22	7	29	48	116	164	1	7	8
1988	173	73	246	75	0	75	70	24	94	26	41	67	2	8	10
1989	226	155	381	17[b]	0	17	149	38	187	60	106	166	0	11	11

				Percent of Total Sample[c]											
Year	Sample Male	Sample Female	Sample Total	Age 4 Male	Age 4 Female	Age 4 Total	Age 5 Male	Age 5 Female	Age 5 Total	Age 6 Male	Age 6 Female	Age 6 Total	Age 7 Male	Age 7 Female	Age 7 Total
1972	66.7	33.3	100.0	0.0	0.0	0.0	53.3	0.0	53.3	13.3	33.3	46.7	0.0	0.0	0.0
1973	60.0	40.0	100.0	10.0	0.0	10.0	0.0	0.0	0.0	50.0	30.0	80.0	0.0	10.0	10.0
1974	0.0	0.0	0.0												
1975	75.0	25.0	100.0	12.5	0.0	12.5	50.0	12.5	62.5	12.5	12.5	25.0	0.0	0.0	0.0
1976	73.3	26.7	100.0	13.3	0.0	13.3	55.6	11.1	66.7	4.4	15.6	20.0	0.0	0.0	0.0
1977	49.6	50.4	100.0	1.7	0.9	2.6	23.1	5.1	28.2	23.1	41.0	64.1	1.7	3.4	5.1
1978	46.8	53.2	100.0	16.9	0.0	16.9	13.0	1.3	14.3	16.9	50.6	67.5	0.0	1.3	1.3
1979	80.4	19.6	100.0	37.0	0.0	37.0	30.4	0.0	30.4	13.0	13.0	26.1	0.0	6.5	6.5
1980	49.4	50.6	100.0	22.9	1.2	24.1	25.3	26.5	51.8	1.2	19.3	20.5	0.0	3.6	3.6
1981	41.4	58.6	100.0	12.5	0.4	12.9	23.2	13.7	36.9	5.7	44.1	49.8	0.0	0.4	0.4
1982	72.5	27.5	100.0	34.1	0.7	34.8	34.1	3.6	37.7	4.3	23.2	27.5	0.0	0.0	0.0
1983	56.5	43.5	100.0	18.3	0.0	18.3	27.5	8.5	35.9	10.8	34.0	44.8	0.0	1.0	1.0
1984	58.7	41.3	100.0	10.5	1.4	12.0	39.1	10.9	50.0	9.1	26.8	35.9	0.0	2.2	2.2
1985	75.8	24.2	100.0	30.3	0.0	30.3	30.3	9.1	39.4	15.2	15.2	30.3	0.0	0.0	0.0
1986	37.3	62.7	100.0	0.0	0.7	0.7	31.0	19.0	50.0	4.2	33.8	38.0	2.1	9.2	11.3
1987	41.4	58.6	100.0	9.5	0.0	9.5	9.9	3.2	13.1	21.6	52.3	73.9	0.5	3.2	3.6
1988	70.3	29.7	100.0	30.5	0.0	30.5	28.5	9.8	38.2	10.6	16.7	27.2	0.8	3.3	4.1
1989	59.3	40.7	100.0	4.5	0.0	4.5	39.1	10.0	49.1	15.7	27.8	43.6	0.0	2.9	2.9

[a]Samples collected mainly by carcass survey. In some years a very few fish were also collected by beach seine or hook and line.
[b]Includes one age-3 male.
[c]Sample percentages not weighted by time period or escapement counts.